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LINGUISTICS.—*Origin of clock-dial V and of zero.*[1]

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In the writing of the entire world there are to be found only six types or systems of figures. Since this fact has never before been brought out, and since the two types of writing figures employed by us are derivative, it will be well first of all to list these types.

1. *Bar.*—Enregistering each unit as a mark, by the placing of something, or by some other signaling of a tally, is the indication of figures most natural to human beings and is well exemplified by the figure system of the Maya, an American Indian population, called the "simple system" to distinguish it from the combinatory system used by the same people. In the Maya system a unit is written as a dot rather than as a bar, while the bar is reserved for the writing of 5. For those figures in the writing of which both dot and bar occur, the dot or dots are placed above a horizontal bar or bars but to the left of a vertical bar or bars, it being immaterial whether the bar be placed horizontal or vertical. The bar system is so simple and self-explanatory that it appears mixed into other systems, as, for instance, into the Chinese, the Roman, and the Arabic systems, as we shall mention below at the close of this listing; it is conspicuously adapted to the writing of 1, 2, and 3 and sometimes of the superquintal derivatives of these, but becomes cumbersome with the writing of 4.

2. *Ideographic.*—This system is well exemplified by the number symbols of Chinese starting with 4, each of the symbols being in origin a picture of a numeral. The Chinese number system is decimal, and for 10 there is written a cross, reminding one of the cross or X by which 10 is expressed in some other systems. Also in ancient Egyptian are to be found ideographic figures. It is very likely that both in Chinese and Egyptian, as in ancient India, certain numerals were identified with certain nouns. For instance, in Egyptian the sickle has in some way become identified with the numeral for 9 and conventionalized as the ideograph for 9.

3. *Alphabetic.*—A language having an alphabet has the letters of this alphabet, whether phonetic or syllabic, for practical purpose in a certain order, known as alphabetic order. As one learns to say an alphabet it becomes natural to assign to each letter a number, and although these numbers would, strictly considered, be ordinal, it is practical to make them cardinal. The common method of writing figures in Greek, for example, was by writing letters. Alpha stood for 1, beta for 2, etc. Many other alphabets had, or have, the same system in practice. Ancient Hebrew used letters of its alphabet as figures, and as such they appear in the numbering of the Psalms. Hebrew had this lettering system as early as the second century B. C. and probably much earlier. This attribution is doubtless as old as the alphabet itself; compare the parallelism of the days of the week being spoken of from the very start also as first day, second day, and so forth.

4. *Alphabetic-decade.*—In the Karosthi figure system of ancient India, *a*, the first letter of the alphabet, stood for 10, not for 1. This is apparently the only evaluate of this sort known to have occurred in the alphabetic world. This strange evaluation of *a* shows that 10 is felt to be a main or round number. That 10 is felt to be the

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A-number-one grouping is evidenced by several other decimal-system languages, being indicated, for instance, by the dd, 20, of the Attic system, the XX, 20, of the Roman system, and in fact by the choice of X for 10 in this latter system versus the standing of X in the Attic system for Greek xfilioi, 1,000.

5. *Initial.*—In the writing of numerals we find that it has been largely the practice in the earlier world to base a system of figures on abbreviated initials—just as indeed the alphabet itself consisted in origin of pictures, each picture symbolizing an initial sound, a conventionalized drawing of a house, baitu in primitive Semitic, standing for *b*, and so forth. We find this numeral-initial-equals-figure system in swing in the Attic figures of ancient Greece and the Roman figures of Latin, which are still in use as our Roman numerals. The Arabic world exhibits both Arabic alphabet figures and the India-derived figures that we call Arabic, in northern Africa the European forms of these figures being in use.

6. *Etymal.*—Persian (now more properly called Iranian) grammars tell of the "Siyaq" figures in use by some merchants in the bazaars in Iran for keeping accounts. A. B. Antar tells me that this writing is also very occasionally employed in Mesopotamia, now called Iraq. Siyaaq, with its second vowel long, is merely the Arabic noun meaning system. The country name with vowel length indicated is Iiraan, but Iraaq. The siyaaq figures are the same as the Arabic alphabetic ones, alif equaling 1, etc., except that for 10 a corrupted contour of the written-out Arabic word for 10 is employed, instead of the Arabic letter ye, or its corruption, which is the ordinary Arabic alphabetic writing for 10.

Mixed systems.—Type 1 usually overrides types 2 and 5 in the denotation of the figures 1 to 3, inclusive, and sometimes in derivatives of these immediately above 5. Standard Chinese writes 1 to 3 by horizontal bars, merchants in China sometimes using vertical bars; Roman has vertical; Arabic has vertical for 1, yet 2 and 3 are corruptions of horizontal.

English inherits two systems of figures. These are the so-called Arabic, really merely transmitted by the Arabs to the western world from India, and the so-called Roman. The Arabic system has general application, the Roman, special and limited, functioning in the pagination of prefaces, on the clock or watch dial, or where inheritance or distinction renders its use desirable.

ORIGIN OF CLOCK-DIAL V

V is for pi, initial letter of Greek pénte, 5.—Just as the Estruscan and Latin alphabets are nothing but forms of the Greek, so the Roman figure system is merely a form of the Attic, the way of writing numerals that appears on all Athenian inscriptions. My discovery, which so far as I know has never been pointed out by anyone else, is that the V of the clock dial, meaning 5, which figure also occurs with apex up in Etruscan, is in origin an inverted Greek letter pi, standing for the Greek numeral pénte, 5.

ORIGIN OF ZERO

Zero arose through conforming, not through invention.—The second discovery announced in this paper is not to be understood without first surveying the linguistic stocks and the linguistic numeral status of India:

There are six stocks in India: 1, Dravidian; 2, Kolarian; 3, Burushaskian; 4, Aryan; 5, Tibetosinan; 6, Andamanian. Stocks 5 and 6 are too largely extraneous to warrant consideration here. Stocks 1 and 2 are upon study probably genetically related. Aryan, though it has been introduced into India from the northwest, is included because Sanskrit Aryan figures are a transmission link between Dravidian and Arab. Aryan is properly with long initial *a*, and is also and more largely called Indo-European or Indo-Germanic. Burushaskian is at present at least a small stock on the Tibetan border of northwestern India but has to be included for completeness. It will be noticed that stocks 1 and 2 carry cardinal classifiers as retrobases. This cardinal classifier in Dravidian has a u-sound, in Kolarian an i-sound. In, for instance, Tamil muu-v-ar, the 3, the u is seen to have turned into v. All the stocks of India happen to have decimal system, derived, of course, from the

human hands together having 10 fingers, and so does the Semitic stock, from the north Mesopotamian writing of which, through the Karosthi and Brahmi alphabets of ancient India, the writing of all the stocks of modern India (barring, of course, Arabic and Latin alphabet writing) is descended.

The Encylopedia Britannica, 14th edition, quotes F. Cajori in his history of mathematics as stating that zero, and the accompanying principle of position in the writing of figures, were what gave superiority to the Indic system. One finds in literature on the history of mathematics a widespread exultation over the invention of zero.

A study merely of the modern Tamil Dravidian writing of figures is enough to convince one that zero was never invented at all, but was the figure for 10. Twenty is in Tamil naturally enough written as 2-10, 30 as 3-10, etc. But 10 is never written as 1-10, since the 1 would here be considered as superfluous. When the writing of 10 became *conformed* by dint of simple analogy to resemble that of 20 and other zero-terminal decade numbers, by placing the symbol for 1 before the symbol for 10, the so-called invention of zero was attained. It was not an invention but a conformity, an accident.

RÉSUMÉ

V on the clock dial is discovered to be an inverted Greek letter pi, zero the result of a conformatory squeezing.

THE UNIT NUMERALS

Tamil (Dravidian Stock)	Mundari (Kolarian Stock)	Sanskrit (Aryan Stock)	Burushaski (Burushaskian Stock)
on^{y}d^{y}u, 1	mid', 1	éeka, 1	hik, 1
iraṇḍu, 2	barĭa, 2	dvá, 2	aalto, 2
muun^{y}d^{y}u, 3	apia, 3	trí, 3	iiski, 3
naan^{y}gu, 4	upunia, 4	catúr, 4	waalti, 4
aindu, 5	moṇṛča, 5	pán^{y}ca, 5	tsindi, 5
aar^{y}u, 6	turŭia, 6	ṣáṣ, 6	mishiindi, 6
eju, 7	eea, 7	saptá, 7	tale, 7
eṭṭu, 8	ĭrĭlia, 8	aṣṭáa, 8	aaltambi, 8
onybadu, 9	aarča, 9	náva, 9	hunti, 9

THE NUMERALS 10, 11, 20, AND 21

pattu, 10	gelea, 10	dáśa, 10	toorimi, 10
padin^{y}-on^{y}d^{y}u, 11	gel miad', 11	éekaa-daśa, 11	turma hik, 11
iru-badu, 20	hisi, also mid' hisi, 20	viṃśatí, 20	aaltər, 20
irubatt-on^{y}d^{y}u, 21	mid' hisi miad', 21	éeka-viṃśatí,21	aaltər hik, 21

BOTANY.—*Genera of the plant viruses.*[1] H. H. MCKINNEY,[2] Bureau of Plant Industry, Soils, and Agricultural Engineering. (Communicated by JOHN A. STEVENSON.)

The number of virus entities known to infect plants is well over 200. In comparison with the thousands of bacteria and fungi, this number is very small, and some workers have accordingly taken the view that there is no pressing need for a formal nomenclature and classification of the viruses at this time. Some take the view that classification should await the results of the chemists, whereas others think unnecessary confusion will prevail, even with so small a number as 200 entities, if such a policy is pursued. It is reasoned that a system can be evolved that will meet the requirements of the patholo-

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[2] The author wishes to acknowledge the helpful advice given by John A. Stevenson, Sidney F. Blake, Charles Drechsler, and others and the assistance given by Charles Drechsler and Edith K. Cash in the choice and orthography of technical names.

gists even after the chemists may have devised a satisfactory system.

A full account of the events leading up to James Johnson's system for designating the plant viruses would require a discussion of many contributions in greater detail than seems necessary in the present paper. Investigators had been gathering evidence indicating that plants are attacked by many different viruses, but the most important stimulus probably came from the investigations of the so-called degeneration diseases of the potato, conducted by Schultz and Folsom in the United States and by Quanjer and others abroad. Schultz and Folsom's paper (1923) was greeted with much skepticism, but when subsequent studies failed to alter their conclusion that many distinct viruses may attack a given plant species it became evident that more than cursory attention should be given to the problem of virus nomenclature and classification.

James Johnson (1927) was the first to emphasize that definite steps should be taken to keep the plant viruses in order. In his scheme the major groups were erected on the basis of the hosts in which the viruses were discovered, and within each of these groups designation was by number.

Quanjer (1931) gave a critical but constructive analysis of some of the problems involved in classification, and although he concluded "that our present knowledge is insufficient for classification of plant viruses," he did divide the viruses of the potato into six categories based on the reactions they induce in selected varieties of potato. These reactions included mosaic and five types of necrosis.

Johnson and Hoggan (1935) proposed a classification based on the means of virus transmission and on the simple properties of the viruses. Later Johnson prepared his extensive lists of virus numbers in mimeographed form. One of these lists (*Illustrations of proposed system of nomenclature of plant viruses*) was prepared by Johnson (1935) as chairman of the International Committee on Descriptions and Nomenclature of Plant Viruses, for use by that committee in its deliberations at the Sixth International Botanical Congress in Amsterdam, 1935. This congress adopted Johnson's proposal in principle, and the International Committee was empowered to continue its considerations and establish an acceptable system of virus nomenclature.

Following this, Kenneth M. Smith in 1937 virtually adopted Johnson's proposal with the exception that he used the Latin generic names rather than the common names of the host plants, and he altered some of Johnson's numerical designations. In both proposals preference was given to the host in which the virus was first discovered, the several viruses assigned to a given host were differentiated by Arabic numerals, and strains were designated by letters of the alphabet. Smith made no attempt to classify within the host groups, but he did compile much valuable information on a large number of viruses and insect vectors.

With these concrete proposals came a general interest in the problem. The slight differences in the approaches by Johnson and by Smith raised several important questions in the minds of virologists, and at the meetings held in Indianapolis (December, 1937), the Council of the American Phytopathological Society appointed a committee to arrange for a discussion of the classification and nomenclature of the plant viruses at the Richmond meeting of the Society in December, 1938. At this meeting these problems were discussed from many angles, and the Society expressed its appreciation to the International Committee on Plant Viruses for the work it had done and recommended that said committee continue its efforts to establish an acceptable system of virus nomenclature (Phytopath. **29**:388). The discussions at Richmond made it clear that opinion was divided with regard to the procedure to be followed in the naming and classifying of the viruses. It was clear that several investigators wished to explore the possibilities of technical names and of making more use of plant reactions in virus classification. It was evident also that most investigators wished to publish without restraint.

A system advanced by Holmes (1939) is particularly noteworthy in that it represents the first comprehensive attempt to make use of induced plant reactions and other virus characteristics in the framing of Latin binomials and trinomials. Holmes erected a kingdom, one division, two classes, and 11 monogeneric families. One of these families in Class I embraces the bacteriophages, whereas the 10 families in Class II embrace the viruses infecting seed plants. No orders are provided in the scheme, and none of the genera is described. Most of the species are described, but some are set up on the basis of varietal descriptions. Five of these varietal descriptions serve as types for genera.

At the meetings of the Society held in Columbus (December, 1939), the council's recommendation, "that the temporary committee on virus nomenclature be made a standing committee," was confirmed and a committee was appointed. Later, however, this committee was designated as a special committee. During 1940 the efforts of the committee were directed largely towards the orientation of the views of its members. Owing to the international situation it became apparent that there would be delay and uncertainty with respect to the efforts of the International Virus Committee, and several American workers published proposals.

Valleau (1940) classified a limited number of viruses infecting *Nicotiana tabacum* L. He set up a genus *Musivum* based on Holmes's *Marmor tabaci* var. *vulgare* as the type species, and he designated this type *Musivum tabaci*. In addition, he set up three other genera to avoid some of the heterogeneity that is evident in Holmes's genus *Marmor* and redefined the genus *Annulus*. However, he did not assign his genera to families, nor did he take a position with respect to the higher groups proposed by Holmes (1939). Valleau took the view that trinomials should not be applied to mutant strains, that there should be a "catch all" genus for viruses about which little is known, and that most of the viruses in the genus *Marmor* should be placed in it. He suggested that *Marmor* might be retained as the "catch all" genus.

Soon after Valleau's paper appeared, Fawcett (1940) proposed an ingenious plan. In his own words, "It is virtually a simplified Smith's system without the confusion of numbers and Holmes' system without the generic difficulties." Fawcett took the position that "we are not ready for genera in the ordinary concept." He proposed that the stem "vir" be added to the Latin genitive of the generic term of the host in which the virus was first discovered and recognized, dropping any final consonants that occur in this genitive. These names serve as virus genera and are identified as such by the suffix. Fawcett took the position that "these derived 'genera pro tem' should not be considered in the ordinary taxonomic sense." The specific and varietal Latin epithets are formed in accord with the established rules of botanical procedure. By this system the peach-rosette virus becomes *Prunivir rosettae* (Holmes) Fawcett.

Thornberry (1941) proposed that all viruses, bacteriophages, and the Rickettsia be placed in one order (Biovirales) in adjunct to the bacteria (class Schizomycetes, phylum Thallophyta of the Plant Kingdom). He proposed that all viruses infecting the seed plants be assigned to a single genus *Phytovirus* in a family Phytoviraceae. Other families and genera were proposed for the viruses infecting zoological species, for the Rickettsia and for the bacteriophages. Specific epithets in Latin would be formed in accordance with the established botanical procedure.

Although the Special Committee on Nomenclature and Classification of Plant Viruses was not given a specific assignment by the Society, it did proceed to study the problem with the idea of making certain recommendations. From the beginning the members seemed to be in full accord on the desirability of a formal system, and after studying the several proposals already on record a majority of the committee came to favor a Latin system of nomenclature (Bennett, et al., 1943). It was believed that a numerical system would lead to considerable difficulty on account of the chances for duplicating numbers, because slight typographical errors are more troublesome in

numbers than in names, and numbers would be more difficult to manage than names when it becomes necessary to clear up the many problems of synonymy that always arise in any field.

It was fully recognized that naming and grouping by hosts is a simple and almost fool-proof procedure and that Fawcett's (1940) proposal represents a very satisfactory and commendable way of applying Latin binomials and grouping viruses by host affinities. However, after a free discussion of the difficulties inherent in other methods of naming and grouping, a majority of the committee took the view that an understanding of virus relationships may evolve more freely if such characteristics as host reactions and modes of transmission serve as the criteria for the genera.

As the committee proceeded in its efforts to draft a proposal, it became evident that there are many details on which it is difficult to obtain agreement at this stage and that many of these details can be decided only after individual workers have had an opportunity to record their views.

GENERAL PROCEDURE

In virus classification the species, genera, families, and higher categories may not be regarded in exactly the same way as they are in the classification of higher plants and animals, but there seems to be no apparent reason why they can not serve the same purpose. The lower categories (species, genus, and family) were conceived by the early philosophers, and they have been and still are used in many departments of knowledge for classifying not only objects but also ideas and languages in various informal ways. The genus has long been regarded as a class more extensive than the species, and the family more extensive than the genus. It seems very clear that these terms denote relative levels in classification and that they may be employed in any branch of knowledge. Linnaeus and others (see Maton, 1805) made use of part or all of these categories in the classifications of minerals and also the human ailments. The Latin binomial system was also applied in these fields. Even today we have such terms as herpes zoster, herpes circinatus, herpes labiales, and molluscum contagiosum to denote certain viruses in man. With the discovery of bacteria, fungi, and Protozoa as etiological agents in disease, it is natural that classification should shift to these agents. However, there can be little doubt that Linnaeus's approach to the problem of disease nomenclature and classification could have served adequately had these etiological agents not been discovered.

In classifying the bacteria it has not been practicable to make use of morphological characteristics throughout; in fact many genera and species are determined by the reactions they induce on suitable substrates. In the fungi the differentiation of strains frequently depends on reactions induced in nutrient media or in suitable host plants, and some genera and many species have been erected on the grounds of preference for some host organ or for some host species.

Bawden (1939) and others have emphasized the high degree of variability of the induced host reactions, and they have taken the view that these reactions are of little value for purposes of virus classification. This high degree of variability is a real problem, but this fact does not necessarily mean that nothing can be done toward reducing variability to a point where host reactions can serve as adequate criteria. The use of host reactions and/or modes of transmission as criteria for virus genera or other categories seems to be a very natural step, because host reactions have long served for the common names, and something is known about means of transmission in all plant viruses. Other virus characteristics have value also, but it appears that such criteria as host range, thermal-death-point, longevity in dry tissue and *in vitro*, reactions to ordinary chemicals, serological reactions, and interference or antagonism between viruses may be of greatest value in the differentiation of species and, in some cases, strains. With the advance of knowledge concerning the histological, cytological, and physiological host reactions induced by viruses, these criteria should assume roles of increasing importance.

Johnson and Hoggan (1935) stressed the classification value of the several modes of transmission and the insect vectors, and they gave these criteria first consideration in their scheme. It is probably too early to generalize on the true value of these criteria, but it does appear that they should be given a thorough trial because certain correlations are suggested. Transmission by inoculation with expressed juice and/or by aphids is rather general among the viruses inducing mosaics, ringspots, and/or necrosis of parenchyma in annual hosts. Whereas, among the woody perennials, similar viruses can be transmitted experimentally for the most part, only through tissue unions or prolonged contact of tissues. It appears that transmission by the hoppers (leafhoppers and planthoppers) obtains in viruses that for the most part are not transmitted by other families of insects (Storey, 1939). Several compilers have indicated that certain viruses are transmitted by both hoppers and aphids, but all claims that have been noted have been checked by the present author in the original papers, and in each instance the claim lacks positive support.

In the scheme here proposed the ten families of Holmes are consolidated into two, Marmoraceae and Rugaceae. All mosaic-inducing viruses and most of those inducing necrosis in parenchyma tissue fall in the Marmoraceae and all viruses characterized by their marked tendency to induce *malformations* but not *mosaic mottling*, all those inducing the *yellows type* of *chlorosis*, and nearly all those known to induce *phloem necrosis* fall in the Rugaceae. The genus *Ruga* is taken as the type for the second family in preference to the genus *Chlorogenus*, because induced malformations seem to be commoner than chlorosis among the viruses that do not fall in Marmoraceae. The two families here proposed essentially provide the two major groups proposed by Bennett (1939).

With very few exceptions the viruses transmitted by expressed juice fall in the Marmoraceae, and with the exception of certain grass-infecting viruses that induce mosaic and/or chlorotic streaking, the hopper-transmitted viruses fall in the Rugaceae. Not all viruses transmitted by white flies are placed in the Rugaceae. The chlorotic reactions induced by the cassava-mosaic virus are typical mosaics according to the writer's observations in West Africa (McKinney, 1929). Furthermore, several mosaic-inducing viruses not transmitted by white flies also tend to induce leaf malformations. At this stage, it seems advisable to place all viruses that induce mosaic mottling in the Marmoraceae.

In the Marmoraceae the means of virus transmission serve as the generic criteria, whereas in the Rugaceae certain host reactions and also the means of transmission serve to differentiate the genera. This procedure is followed at the generic level because it appears that the use of such criteria as thermal-death-point, interference, resistance to aging, and serological reactions would cause difficulties at the species and strain levels. Eighteen genera are described from the information in Holmes's descriptions of the species and the varieties and from information gathered from other sources. Owing to the large volume of literature, however, many original papers are not cited, but reference is made to papers and compilations having extensive literature lists.

Insect vectors with chewing mouth parts are disregarded in the scheme of classification. Vectors with sucking, lapping, or rasping mouth parts, with a few exceptions noted later, are segregated on the basis of insect families. This method of segregation does increase the number of virus genera, but it appears to be one of the surest ways to obtain an objective evaluation of the criteria.

In the genus *Fractilinea* transmission by the two families of hoppers (leafhoppers and planthoppers) is combined, and in the genus *Savoia* transmission by the two families of true bugs is combined. This is done for convenience. When it is considered that members of very closely related insect families are subject to taxonomic rearrangement, it is impracticable at this stage to place a true value on some of these families as criteria for erecting separate virus genera.

It is suspected, however, that some of these insect families may serve as criteria for new virus genera later. On the other hand, it is quite possible that some of the genera may be combined later—*Ruga* and *Savoia*, for example—as certain aphids and true bugs are known definitely to transmit the virus of potato spindle-tuber and also the virus of potato unmottled curly-dwarf in the genus *Acrogenus*.

Transmission by inoculation with expressed juice is rare among the viruses transmitted by hoppers. With the curly-top virus of beet and the yellow-dwarf virus of potato, juice transmission is difficult and dependent on special hosts. In the classification of these viruses emphasis is placed on the vectors.

Viruses within a given host-reaction group that are transmitted by aphids and/or by expressed juice are placed together, and those viruses with which known transmission is limited to tissue union (grafting, budding, dodder unions) or to prolonged contact of tissues without union, are segregated in each host-reaction group in which they occur. Viruses that have been transmitted only by tissue union or by prolonged contact of tissues may be transferred to appropriate genera, or new genera may be established as the vectors are discovered or as transmission by expressed juice is effected. The 6 genera erected for these viruses fulfill the purposes of a single temporary group that was suggested by Valleau (1940). Since it is likely that a large number of viruses would be assigned to a single such group, it seems more practicable to arrange for their classification in the several host-reaction categories, as is done in the proposed scheme, because it is entirely possible that transmission by inoculation with expressed juice may not be effected. Furthermore, the vectors may not be discovered for some of these viruses for many years.

The superstructure of the scheme seems to be of relatively little importance at this time. However, the higher categories are arranged to permit the inclusion of the bacteriophages and the viruses infecting zoological species, as was planned in the scheme devised by Holmes (1939). In Holmes's scheme there are no orders, and Vira is given the rank of kingdom. Thornberry (1941) proposed that an order Biovirales be set up in the class Schizomycetes to embrace the viruses and the bacteriophages. It appears that there is some justification for assigning the viruses to the Plant Kingdom, but it seems unnecessary and unwise to contemplate redefining the Thallophytes, Fungi, and Schizomycetes to accommodate the proposed order Biovirales. In the present scheme the viruses are regarded as exceedingly low forms of life. The study of virus mutants (Holmes, 1936; McKinney, 1937 and 1941) indicates that fixed strains behave essentially as simple genic systems, and, although mutation has not been demonstrated in all viruses, it appears clear that the phenomenon occurs in several that are known to be high-molecular-weight nucleoproteins (Jensen, 1933; McKinney, 1935; Price, 1934). Furthermore, the slight differences *inter se* manifested by some of the wheat-mosaic viruses (McKinney, 1937a), the sugarcane viruses (Summers, 1934), the curly-top viruses (Giddings, 1938), and by several other viruses strongly suggest common ancestries within certain limited groups.

Since the lowest forms of life are usually included with the plants, it is proposed that the viruses be accorded the rank of *division* in the Plant Kingdom, and that this division be designated Viriphyta. It is further proposed that the procedure in virus nomenclature be governed by the International Rules of Botanical Nomenclature (Briquet, 1935) in so far as seems practicable. Subfamilial and tribal designations are purposely omitted in the present scheme.

Although certain viruses manifest natural affinities, it is believed that the plant viruses, like the fungi and other lower forms, do not represent a natural group throughout. Because of the very small number of characters available at any given group level, some of the generic descriptions are very similar with respect to the host reactions. This weakness should gradually disappear with the advance of knowledge concerning the direct characters of the viruses and the induced host reactions. Of

the latter, it appears that the cytological and microchemical reactions should become of increasing objective importance as the studies of Bennett (1940), Esau (1935), Hutchins (1933), Kassinis and Sheffield (1941), McWhorter (1941), Rawlins and Thomas (1941), Simonds and Bodine (1943), and many others are extended to additional viruses and hosts. Because of the nature of viruses, the accumulation of many coordinating and contrasting criteria at the generic level will require time.

DEFINITIONS

The term *virus* is used just as the terms *bacterium*, *fungus*, or *organism* are used to indicate infectious entities.

The term *strain* refers to any virus of intraspecific rank, regardless of its rank in the species.

A *species* is regarded as a group of strains, actually or potentially.

DETAILED METHODS OF PROCEDURE AND SUGGESTIONS

The International Rules of Botanical Nomenclature (Briquet, 1935) serve as the basis of procedure in the present paper, except that descriptions are not in Latin and Articles 41, 42, and 44 are not rigidly applied.

Descriptions of varieties without descriptions of the species or of the genera (Holmes, 1939 and 1941) are without precedent and create difficulties. Also, a system comprised of families, all of which are monogeneric, is without precedent. Technically all these genera and all the binomials that are based only on varietal descriptions may be regarded as *nomina nuda*. However, it appears that the best interests of virus nomenclature will not be served by a rigid application of Articles 41, 42, and 44 at this time.

Eight of Holmes's (1939 and 1941) generic names are retained and supported by descriptions based on information obtained from original sources and from Holmes's handbooks. Four of these genera, *Marmor*, *Lethum*, *Chlorogenus*, and *Acrogenus*, were founded on viruses that Holmes designated by trinomials. Although Holmes used the varietal epithets *vulgaris* and *typicus*, the procedure he followed in setting up his descriptions is not in conformity with the concept of *typicus* in relation to the specific descriptions (Ley, 1943; Croizat, 1943), and it is concluded that these four genera were founded on varieties and not on species. The writer's descriptions of these four genera are for the present regarded as emendations, and authorities are so indicated.

Valleau's (1940) description of *Musivum tabaci* is regarded as the first valid publication of the specific epithet *tabaci*, which as *Marmor tabaci* becomes a new combination and the type species of the genus *Marmor* in the present proposal. The descriptions of the type species *Lethum australiense*, *Fractilinea maidis*, *Chlorogenus callistephi*, and *Acrogenus solani* in this proposal are regarded as first valid publications. In these four species, authority for the specific epithet and authority for the description of the epithet is divided, as provided in Article 48 of the International Rules, i.e., name of the author who supplied the description being appended to the citation with the connecting word *ex*.

The following suggestions are offered:

1. The type-species concept can be applied only in a limited way to the plant viruses. As there are but few of these causal agents that can be maintained indefinitely without great expense, the burden rests on suitable descriptions and photographic records. In this proposal, no genus has been retyped. Even though some of the type species are little known, it appears that the best interests of virus nomenclature will be served if these nomenclatural types are preserved in accordance with Article 18.

2. The technical descriptions for purposes of classification should be confined to those characteristics that seem essential to proper classification. Other sources should be relied upon for the complete information on most of the viruses.

3. In the binomial system, the specific and the generic descriptions are more important than the descriptions of any of the higher categories, and even though a genus may be monotypic its characterizing features can and should be clearly set forth apart from the descriptions of the species, and the family. Each species should be designated as a binomial and be described.

4. In those genera in which transmission by tissue union is the criterion, the species should be transferred to other genera as transmission by expressed juice is effected or as insect vectors are discovered. To avoid needless changes in nomenclature it is suggested that these generic names be retained even if the type species are transferred.

5. A given virus may induce a wide range of reactions in its several suscepts, therefore, it is necessary to select the host or hosts that best characterize it.

6. The host reactions employed in the scheme are induced by viruses that are established in nature, and which may be regarded essentially as wild types. The scheme is adequate for many mutants isolated in the laboratory, but with some of these that induce indefinite reactions, the generic allocations will be determined on the basis of other suitable criteria that indicate relationship to a wild type.

7. Since so many viruses induce general dwarfing of the plant, this characteristic should be emphasized in classification only when the virus induces few other diagnostic reactions.

8. The phenomenon of compatibility and incompatibility (interference, antagonism, cross protection) between viruses may be expressed in varying degrees, depending on the viruses that are being tested, on the host, and on the environment (McKinney, 1941a). It seems unwise to assume that the phenomenon should serve as a single means for "proving" or "disproving" natural relationship between little-known viruses, but like any other character, when properly used, it may serve as a criterion for differentiating virus groups. Throughout botany and zoology there is ample evidence that the concept of relationship evolves from a knowledge of many characters at each of the levels in a particular scheme.

GENERA OF THE PLANT VIRUSES

Kingdom PHYTA

Division VIRIPHYTA

Syn.: Kingdom Vira Holmes (1939).

Causal agents of infectious diseases, ultramicroscopic in size, propagating only in association with living cells; in some cases capable of mutation and originating fixed strains that behave as simple genic systems and exceedingly low forms of life.

Class PHYTOPHAGI

Syn.: Division Phytophagi Holmes (1939).

Viruses pathogenic in plants.

Order SPERMATOPHYTOPHAGALES

Syn.: Class Spermatophytophagi Holmes (1939).

Viruses pathogenic in the seed plants.

Family 1. MARMORACEAE Holmes emend.

Annulaceae Holmes (1939); Lethaceae Holmes (1939); Rugaceae Holmes (1939) p.p.; Nanaceae Holmes (1939) p.p.

Viruses inducing disturbances of the plastid pigments causing mosaic mottling, veinbanding, discrete chlorotic spotting or streaking in the foliage; local necrotic spotting and/or systemic necrosis. Bud proliferation and malformations of the foliage are attendant reactions in some instances, but these reactions do not typify the family. All mosaic-inducing viruses fall into this family. Transmission of many species by expressed juice and/or by aphids, a few species by leafhoppers, planthoppers, or other insects, and many species by tissue union. Type genus, *Marmor* Holmes (1939) emend.

KEY TO THE GENERA

A. Transmission by expressed juice.
  1. Insect vectors aphids or unknown..... Genus 1. *Marmor*
  2. Insect vectors thrips..... Genus 2. *Lethum*

B. Transmission limited to insect vectors and/or to tissue union.[3]
  1. Transmission by aphids... Genus 3. *Poecile*
  2. Transmission by leafhoppers or planthoppers..... Genus 4. *Fractilinea*
  3. Transmission by white flies..... Genus 5. *Ochrosticta*
  4. Transmission by tissue union, insect vectors unknown..... Genus 6. *Flavimacula*

[3] Throughout the keys, *transmission by tissue union* includes grafting, budding and dodder unions, and prolonged contact of cut tissues without organic union.

Genus 1. **Marmor** Holmes emend.

Marmor Holmes (1939), p.p.; *Annulus* Holmes (1939); *Musivum* Valleau (1940); *Murialba* Valleau (1940); *Foliopellis* Valleau (1940); *Tractus* Valleau (1940).

Viruses inducing disturbances of the plastid pigments and/or necrosis, especially in the parenchyma tissues, causing chlorotic mosaic mottling or spotting, oak-leaf patterns, ring spotting, local necrotic lesions, and sometimes systemic necrosis; malformations and/or bud proliferations sometimes accompanying the chlorotic reactions; sometimes disturbances in the glucoside pigments, especially in certain graminaceous hosts, causing purple and red colorations. Transmission by expressed juice in all members; insect vectors aphids (Aphididae) or unknown. Type species, *Marmor tabaci.*

Marmor embraces most of the species inducing the typical mosaics and the ringspots, nearly all the species that can be studied outside the plant, and all species known to be nucleoproteins. Most of the suscepts are herbaceous annuals.

Marmor tabaci (Holmes ex Valleau), comb. nov.

Tobacco virus 1 Johnson (1927); Nicotiana virus 1 Smith (1937); *Marmor tabaci* var. *vulgare* Holmes (1939); *Musivum tabaci* (Holmes ex Valleau) Valleau (1940).

Common name.—Tobacco-mosaic virus.

Host reactions.—In *Nicotiana tabacum* L. var. Samsun (Turkish) and most other commercial varieties of tobacco, *N. sylvestris* Spegaz. and Comes, *Lycopersicon esculentum* Mill. var. Bonny Best, and other commercial varieties of tomato, virus increase is very great and induces conspicuous light-green mosaic mottling at all the usual culture temperatures; in the tobaccos the reactions manifest acute and chronic types (McKinney and Clayton, 1943), especially under field culture when acute burning occurs in var. Maryland Medium Broadleaf and certain other varieties; virus content of leaves with acute chlorosis higher than in leaves with chronic mosaic. In *N. glutinosa* L. and *N. rustica* L., induces local necrotic lesions, systemic necrosis or mosaic mottling when cultured at 24°, 31°, or 37° C., respectively. In *Plantago major* L. secondary symptoms are feeble or null. In certain collections of *N. tabacum* from Colombia (derivatives from Ambalema tobacco and T.I. 448 tobacco, McKinney, 1943), and in *N. glauca* R. Grah., virus increase is very low, inducing only occasional chlorotic spots or no visible reactions. *Cucumis sativus* L. is immune. This species has a very wide host range.

Transmission.—Readily by inoculation with expressed juice in the suscepts listed, by the following aphids (Aphididae): *Macrosiphum gei* Koch, *Myzus pseudosolani* Theob., and *M. circumflexus* (Buckt.), after feeding on infected *Lycopersicon esculentum;* by tissue union (grafting and dodder).

Mutation.—All field collections of the species (wild types) are very similar but not identical in all hosts; all collections that have been studied have given rise to aberrant types. Interference or antagonism (protection) has occurred in all tests thus far in which wild types were in combination with their known mutants, and the wild types have always dominated and supplanted the mutants in the new tissues. Combinations of these mutants, also combinations of *Marmor tabaci* and certain other virus species, have shown that interference is definitely a quantitative phenomenon that is influenced by the viruses in combination, by the host and by the external environment (McKinney, 1941a).

Physical and chemical properties.—The type virus and the strongly invasive strains tested thus far are inactivated at 88° to 93° C. in 10 minutes in plant juices; activity not lost completely after storage for many years in dry tissue or plant extract at room temperature; dilution end-point in fresh plant extract from mosaic tobacco 1,000,000 ×or beyond; ultimate particle (micelle or molecule) rod shaped with a minimal diameter of particles about 11.5mμ; paracrystals at p_H 4.5, length 3.2 to 4.2μ, width 0.4 to 0.5μ; high molecular-weight nucleoproteins; possessing antigenetic properties that distinguish it from other virus species, and that serve to distinguish between some but not all its strains.

Distribution.—World wide with tobacco culture.

Type virus.—James Johnson, University of Wisconsin, Madison, Wis.; Rockefeller Institute for Medical Research, Department of Animal and Plant Pathology, Princeton, N. J.;

H. H. McKinney, U. S. Bureau of Plant Industry, Soils, and Agricultural Engineering, Beltsville, Md.

Genus 2. **Lethum** Holmes emend.

Viruses inducing disturbances causing bronzing, chlorotic and necrotic spotting, and ringspotting in foliage; in some hosts typical mosaic mottling; severe necrosis and death in certain hosts; distortion and curling of leaves sometimes as attendant reactions. Transmission by expressed juice; all species transmitted by thrips (Thripidae). Type species, *Lethum australiense*.

Lethum australiense Holmes[4]

Tomato virus 1 Johnson (1935); Lycopersicon virus 3 Smith (1937); *Lethum australiense* var. *typicum* Holmes (1939).

Common name.—Tomato spotted-wilt virus.

Host reactions.—In *Lycopersicon esculentum* Mill. var. Bonny Best and other commercial varieties of tomato, induces a bronze coloration necrosis, and sometimes mottling; bronzing involving entire surface of leaflet or occurring as rings, which become necrotic; necrosis first involving the upper epidermal cells, then the spongy parenchyma; systemic necrosis sometimes killing plants when infected as seedlings; pale red, yellow, or white blotching on ripe fruit, sometimes involving most of surface. In *Nicotiana tabacum* L. var Samsun (Turkish), and var. White Burley, induces local necrotic lesions or plaques on the inoculated (wiped) leaves; necrosis sometimes systemic and fatal to the plant or to all leaves except those in the growing tip; sometimes systemic mottling. In *Petunia* sp. (garden varieties) local reddish-brown lesions with pale centers; rarely systemic.

In *Nicotiana glutinosa* L. local necrotic lesions that become larger than those induced by *Marmor tabaci;* systemic necrosis and death of plant in some cases. In *Datura stramonium* L. concentric-ring spotting, necrotic oak-leaf patterns; typical mosaic mottling, especially during summer season. In *Pisum sativum* L. (garden varieties) systemic necrotic streaks in stem and veins of leaflets; sometimes local necrotic spots on wiped leaflets; necrosis involving parenchyma tissue and phloem; sometimes a mottled pattern on leaves infected when young. In *Ananas sativus* L. induces the yellow-spot disease (Hawaii); in *Nicotiana tabacum* the "vira-cabeca" (Brazil); in *N. tabacum* and *Lycopersicon esculentum* the "krom-neck" disease (So. Africa); in *N. tabacum* the "corcova" disease (Argentina), and in *L. esculentum* the tip-blight disease (Oregon and W. Virginia)—the causal agents, if not identical with *Lethum australiense*, appear to be strains. Collections of this virus or its strains that have been observed in tobacco by the author, induced reactions that were strikingly similar to those induced by the tobacco ringspot virus. *L. australiense* has a very wide host range.

Transmission.—By inoculation with expressed juice wiped on leaves dusted with fine carborundum dust, grain 600 or equal; by the following thrips (Thripidae): *Thrips tabaci* Lind., *Frankliniella pauicispinosa* Moult., *F. moultoni* Hood, *F. lycopersici* Andr., and *F. occidentalis* Perg.

Physical and chemical properties.—Inactivated at temperatures near 42° C. in 10 minutes in plant juices; in a few hours at room temperatures in plant juices or in drying itssue. Dilution end-point between 10,000 and 100,000 ×. Passes Gradocol membrane with pore diameter of 450 mμ.

Distribution.—Australasia, United States, Great Britain, probably Hawaii, South Africa, and South America.

Genus 3. **Poecile,** gen. nov.

Marmor Holmes (1939) p.p.

Viruses inducing disturbances of the plastid pigments causing mosaics, marginal yellowing, of yellow patching in foliage; in some cases bud proliferation and leaf malformations are attendant reactions. Transmission by expressed juice not typical, null or exceedingly difficult; all species transmitted by aphids (Aphididae). Name from Latin meaning variegation (fem.). Type species, *Poecile rubi*.

Poecile rubi (Holmes), comb. nov.

Raspberry virus 2 Johnson (1935); Rubus virus 1 Smith (1937); *Marmor rubi* Holmes (1939).

Common name.—Raspberry-mosaic virus.

Genus 4. **Fractilinea,** gen. nov.

Marmor Holmes (1939) p.p.

Viruses inducing disturbances of the plastid

[4] For citation of authority see p. 145, col. 2, par. 1.

pigments causing pale green to yellow or almost white opaque or translucent streaks (continuous or broken), spotting or speckling; bud proliferation (rosetting) and marked general dwarfing in some cases. Transmission by expressed juice not typical, null or exceedingly difficult; all species transmitted by leafhoppers or planthoppers (Cicadellidae or Fulgoridae). Name from two Latin words signifying *interrupted* and *line* (fem.), referring to the broken chlorotic lines and streaks induced in the leaves. Type species, *Marmor maidis.*

Fractilinea maidis (Holmes),[5] comb. nov.

Corn virus 2 Johnson (1935); Zea virus 2 Smith (1937); *Marmor maidis* var. *typicum* Holmes (1939).

Common name.—Maize (corn)-streak virus.

Host reactions.—In *Zea mays* L. and *Saccharum officinarum* L. var. Uba. induces light-green spots, broken and continuous chlorotic streaks. On the latter host the reactions are milder and the virus does not persist in the new foliage.

Transmission.—By the following leafhoppers (Cicadellidae): *Cicadulina* (*Balclutha*) *mbila* (Naudé), *C. storeyi* China, and *C. zeae* China; not by inoculation with expressed juice. *Cicadulina mbila* is heterozygous for the virus-transmission character, and this character is sex linked. No morphological characters have been found that distinguish the race that transmits from the one that cannot transmit virus. Presumably the difference is in the permeability of the intestinal wall.

Mutation.—Not demonstrated. *Marmor maidis* var. *sacchari* Holmes (1939) and *M. maidis* var. *mite* Holmes (1939) are similar to *Fractilinea maidis,* but it is largely a matter of opinion as to their rank. They may represent strains of *F. maidis* or they may be closely related species.

Physical properties.—Virus passes a Chamberland L_3 filter but is retained by the Seitz E. K. filter disk when the p_H is near 6.

Distribution —Africa.

Genus 5. **Ochrosticta,** gen. nov.

Ruga Holmes (1939) p.p.

Viruses inducing mosaic mottling. Leaf deformations and bud proliferations sometimes attendant reactions, but these do not characterize the genus. Transmission by expressed juice null; all species transmitted by white flies (Aleyrodidae). Name from two Greek words meaning *yellow* and *dapple* (fem.), referring to the chlorotic mottling reaction. Type species, *Ochrosticta bemisiae.*

Ochrosticta bemisiae (Holmes), comb. nov.

Manihot virus 1 Smith (1937); *Ruga bemisiae* Holmes (1939).

Common name.—Cassava-mosaic virus.

Genus 6. **Flavimacula,** gen. nov.

Marmor Holmes (1939) p.p.; *Nanus* Holmes (1939) p.p.

Viruses inducing disturbances of the plastid pigments causing chlorotic and/or necrotic spotting and sometimes mosaics with attendant rosetting of leaves; a few species inducing disturbances of the glucoside pigments, but no striking bud proliferation; malformations such as leaf curling, etc., sometimes are attendant reactions. Experimental transmission limited to tissue union; insect vectors not known. Name from two Latin words meaning *yellow* and *spot* or *smear* (fem.), referring to the chlorotic spotting or mottling reaction. Type species, *Flavimacula persicae.*

Flavimacula persicae (Holmes), comb. nov.

Peach virus 6 Johnson (1935); Prunus virus 5 Smith (1937); *Marmor persicae* Holmes (1939).

Common name.—Peach-mosaic virus.

Many members of this genus have rosaceous hosts, relatively few typical mosaic patterns are induced and little is known concerning properties other than host reactions and the mode of transmission.

Family 2. RUGACEAE Holmes emend.

Nanaceae Holmes (1939) p.p.; Coriaceae Holmes (1939); Savoiaceae Holmes (1939); Marmoraceae Holmes (1939) p.p.; Chlorogenaceae Holmes (1939); Acrogenaceae Holmes (1939) and Gallaceae Holmes (1939).

Viruses inducing cellular disturbances causing various malformations such as bud proliferation (rosetting or brooming), thickening of tissues, enation, leaf curl, galls, cortical lesions (cankers), vascular proliferation and/or dwarfing. Phloem necrosis induced by some members

[5] See footnote 4.

(necrosis sometimes extending well into the parenchyma). Many members not inducing striking attendant disturbances of the plastid or glucoside pigments; pigment disturbances when evident usually involving entire leaves or diffuse patches causing the yellows type of chlorosis, and not mosaic; some species tending to induce intensification of green coloration. Transmission frequently limited to tissue union and/or to insect vectors; few species transmitted by inoculation with expressed juice. Type genus, *Ruga* Holmes (1939) emend.

KEY TO THE GENERA

A. Viruses inducing bud proliferation causing brooming or rosetting; sometimes dwarfing reactions.
  1. Viruses inducing pigment disturbances in foliage
    a. Transmission by leafhoppers..... .....Genus 1. *Chlorogenus*
    b. Transmission by tissue union, insect vectors not known. Genus 2. *Chlorophthora*
  2. Induced pigment reactions null, inconspicuous or inconstant.
    a. Transmission by aphids..... .....Genus 3. *Blastogenus*
    b. Transmission by tissue union, insect vectors not known....Genus 4. *Polycladus*
B. Viruses inducing chiefly malformations of foliage as curling, crumpling, rolling, perforation, laceration, enations, galls, dwarfing; maldevelopment and/or malformation of fruit; general dwarfing of plant usually an attendant reaction. Virus-induced proliferation null or inconstant; general chlorosis and/or accentuation of glucoside pigments induced by a few members, but not a characteristic of the group.
  1. Transmission by aphids...Genus 5. *Corium*
  2. Transmission by true bugs. Genus 6. *Savoia*
  3. Transmission by leafhoppers or planthoppers .....Genus 7. *Galla*
  4. Transmission by white flies. Genus 8. *Ruga*
  5. Transmission by tissue union, insect vectors not known.....Genus 9. *Carpophthora*
C. Viruses characterized by their reactions in and near cortex of the trunk and branches; reactions in other parts null or of low diagnostic value.
  1. Transmission by tissue union, insect vectors not known.....Genus 10. *Rimocortius*
D. Viruses inducing general dwarfing of host or its parts; green coloration of foliage frequently intensified; other reactions null or of low diagnostic value.
  1. Transmission by expressed juice, vectors aphids and/or true bugs or not known .....Genus 11. *Acrogenus*
  2. Transmission by tissue union, insect vectors not known.....Genus 12. *Minuor*

Genus 1. **Chlorogenus** Holmes emend.

Chlorogenus Holmes (1939) p.p.

Viruses inducing bud proliferation causing brooming or rosetting of shoots or leaves; malformation and dwarfing of leaves; pigment disturbances causing general yellowing or diffuse yellowish patching of foliage; disturbances of glucoside pigments sometimes causing reddening and purpling of foliage. No typical mosaic mottling. Transmission by expressed juice null or too difficult for purposes of classification; all species transmitted by leafhoppers (Cicadellidae). Type species, *Chlorogenus callistephi.*

Chlorogenus callistephi Holmes[6]

Callistephus virus 1 Smith (1937); *Chlorogenus callistephi* var. *vulgaris* Holmes (1939).

Common name.—Aster-yellows virus.

Host reactions.—In *Callistephus chinensis* Nees. stimulates lateral bud and side-shoot development; shoots slender, wiry and upright, tending to have long internodes; shortening of main-stem internodes; leaves narrow, deformed and upright; induces general chlorosis, especially in young tissues (leaves, petioles, stem, and branches); sectorial chlorosis occurring in some leaves, but never mosaic mottling; floral straps becoming virescent, and their trichomes frequently developing into leaflike structures; mild necrosis usually appearing just below apex of the stem, flowers usually sterile. The stimulation of buds with the development of side shoots is somewhat more constant than the chlorotic reaction among the many susceptible host species.

Transmission.—By the leafhopper (Cicadellidae) *Macrosteles divisus* (Uhl.); by grafting; not by inoculation with expressed juice.

Physical properties.—Inactivated in the insect vector in 12 days at 31° C.

Distribution.—United States; Canada, Bermuda, Hungary, and Japan.

Genus 2. **Chlorophthora,** gen. nov.

Chlorogenus Holmes (1939) p.p.; *Nanus* Holmes (1939) p.p.

Viruses inducing bud proliferation causing brooming of twigs or rosetting of leaves, chlorosis or bronzing, malformation and dwarfing of foliage, malformation and sometimes in-

[6] See footnote 4.

tensification of color in fruit. Experimental transmission limited to tissue union; insect vectors not known. Name from two Greek words meaning *green* and *destruction* (fem.) referring to the destruction of chlorophyll induced in the foliage. Type species, *Chlorophthora solani*.

Chlorophthora solani (Holmes), comb. nov.

Potato virus 11 Johnson (1935); Solanum virus 15 Smith (1937); *Chlorogenus solani* Holmes (1939).

Common name.—Potato witches'-broom virus.

Genus 3. **Blastogenus,** gen. nov.

Nanus Holmes (1939), p.p.

Viruses inducing bud proliferation causing brooming or rosetting of twigs or leaves without striking chlorosis. Transmission by expressed juice null or too difficult for purposes of classification; all species transmitted by aphids (Aphididae). Name from two Greek words signifying *bud* and *producing* (masc.), referring to the large number of buds activated. Type species, *Blastogenus fragariae*.

Blastogenus fragariae (Holmes), comb. nov.

Strawberry virus 2 Johnson (1935); Fragaria virus 3 Smith (1937); *Nanus fragariae* Holmes (1939).

Common name.—Strawberry witches-broom virus.

Genus 4. **Polycladus,** gen. nov.

Chlorogenus Holmes (1939) p.p.; *Galla* Holmes (1939) p.p.; *Nanus* Holmes (1939) p.p.

Viruses inducing bud proliferations causing brooming or rosetting of twigs, leaves or floral parts; no striking chlorosis; malformations and/or dwarfing of leaves. Experimental transmission limited to tissue union; insect vectors not known. Name from two Greek words signifying *many shoots* or *branches* (masc.), referring to the excessive number of shoots induced. Type species, *Polycladus robiniae* Holmes (1939).

Polycladus robiniae (Holmes), comb. nov.

Robinia virus 1 Smith (1937); *Chlorogenus robiniae* Holmes (1939).

Common name.—Locust witches'-broom virus.

Genus 5. **Corium** Holmes (1939)

Corium Holmes (1939); *Nanus* Holmes p.p. (1939).

Viruses inducing foliar malformations as rolling, puckering, wrinkling, dwarfing etc.; some species inducing mild general chlorosis in the leaves; no consistently striking bud proliferation. Transmission by expressed juice null or too difficult for purposes of classification; all species transmitted by aphids (Aphididae). Type species, *Corium solani*.

Corium solani Holmes (1939)

Potato virus 1 Johnson (1935), Solanum virus 14 Smith (1937).

Common name.—Potato leaf-roll virus.

Genus 6. **Savoia** Holmes (1939)

Viruses inducing foliar malformations as wrinkling, twisting, curling, dwarfing, etc.; phloem necrosis in roots and premature death of host in some cases; chlorosis when evident is diffuse, not typical mosaic. Transmission by expressed juice in some cases, but with difficulty; all species transmitted by true bugs (Tingitidae or Miridae). Type species, *Savoia betae*.

Savoia betae Holmes (1939)

Sugar-beet virus 3 Johnson (1935); Beta virus 3 Smith (1937).

Common name.—Beet leaf-curl virus.

Genus 7. **Galla** Holmes (1939)

Marmor Holmes (1939), p.p.; *Chlorogenus* Holmes (1939), p.p.; *Galla* Holmes (1939), p.p.

Viruses inducing malformations of foliage as curling, rolling, cupping, crumpling, galls; degeneration or necrosis of the phloem sometimes extending well into the parenchyma tissues; chlorosis (not mosaic mottling) and/or bud proliferation in some hosts but chlorosis and proliferation do not characterize the genus. Transmission by expressed juice null or too difficult for purposes of classification; all species transmitted by planthoppers (Fulgoridae) or by leafhoppers (Cicadellidae). Type species *Galla fijiensis*.

Galla fijiensis Holmes (1939)

Sugar-cane virus 2 Johnson (1935); Saccharum virus 2 Smith (1937).

Common name.—Sugarcane Fiji-disease virus.

Genus 8. **Ruga** Holmes (1939)

Ruga Holmes (1939), p.p.

Viruses inducing foliar malformations as rolling, puckering, wrinkling, dwarfing, etc.; thickening of veins; mild chlorosis (not mosaic mottling) in some cases but this reaction is too inconstant for purposes of classification. Transmission by expressed juice null or too difficult for use in classification; all species transmitted by white flies (Aleyrodidae). Type species *Ruga tabaci*.

Ruga tabaci Holmes (1939)

Tobacco virus 16 Johnson (1935); Nicotiana virus 10 Smith (1937).

Common name.—Tobacco leaf-curl virus.

Genus 9. **Carpophthora,** gen. nov.

Marmor Holmes (1939) p.p.

Viruses inducing foliar malformations as twisting, enations, warts, rolling, folding, puckering, tattering, perforation; early drop of leaves and fruit in some hosts; maldevelopment and malformations in fruit in some cases without reactions in foliage; some members inducing yellowing and reddening or purpling of foliage, bark cankers, phloem necrosis, twig die-back and sometimes death of tree; bud proliferation null or not a striking characteristic, and not typifying the genus. Experimental transmission limited to tissue union; insect vectors not known. Name from two Greek words signifying *fruit* and *ruin* or *destruction* (fem.). Type species, *Carpophthora lacerans*.

Carpophthora lacerans (Holmes), comb. nov.

Marmor lacerans Holmes (1939).

Common name.—Peach X or yellow-red-disease virus (Hildebrand et al. 1942).

If this virus, sweet-cherry buckskin-disease virus (Rawlins and Thomas, 1941), and peach-leaf-casting-yellows virus (Thomas, Rawlins, and Parker, 1940) are identical, consideration should be given to the common name "buckskin disease," which antedates the other names. (See the literature lists in Hildebrand et al., 1942.)

Genus 10. **Rimocortius** Milbrath and Zeller (1942)

Viruses inducing reactions chiefly in the cortical region of woody stems and branches causing swelling, scaling, cracking, checking, splitting, cankering, and/or gumming; splitting and crosscracking of the midribs of leaves, causing leaf curling in some instances. Chlorosis absent or not striking, sometimes vein clearing or stippling, but not typical mosaic mottling. Experimental transmission limited to tissue union or possibly to prolonged contact of tissue without organic union; insect vectors not known. Type species, *Rimocortius kwanzani*.

Rimocortius kwanzani Milbrath and Zeller (1942)

Common name.—Flowering-cherry rough-bark virus.

Host reactions.—In *Prunus serrulata* Lindl. var. *Kwanzan*, induces longitudinal and transverse splitting, and deep brown coloration of the bark; shortening of stem internodes and clustering of leaves; downward arching or curling of leaves, with frequent longitudinal and transverse cracking of the underside of the midribs; general dwarfing of the tree and reduced number of lateral branches. No definite chlorotic reactions in foliage. Wild *P. avium* L. (Mazzard) is a symptomless carrier of the virus. Other varieties of *P. serrulata* apparently are immune.

Transmission.—By budding and grafting; organic union need not be sufficient for bud development (possibly a prolonged contact of tissues without organic union is sufficient to effect transmission). No insect vectors have been found.

Distribution.—Oregon.

Genus 11. **Acrogenus** Holmes emend.

Viruses inducing a general dwarfing of plants and/or foliage; chlorosis; rolling and wrinkling of foliage null or slight, intensification of green coloration of foliage a common reaction. Transmission by expressed juice in all species; insect vectors aphids (Aphididae) and/or true bugs or not known. Type species, *Acrogenus solani*.

Acrogenus solani Holmes[7]

Potato virus 8 Johnson (1935); Solanum virus 12 Smith (1937); *Acrogenus solani* var. *vulgaris* Holmes (1939).

Common name.—Potato spindle-tuber virus.

Host reactions.—In *Solanum tuberosum* L., induces delayed emergence; stiff, spindly, erect

[7] See footnote 4.

stems; small, erect, dark-green leaves with slender brittle petioles; twisted terminal leaves; elongated, cylindrical, tapered tubers with irregular contour, smooth tender skin and prominent eyes, flesh of tubers brittle at harvest, but softer than normal after storage.

Transmission.—By inoculation with expressed juice, by aphids (Aphididae), *Myzus persicae* (Sulz.) and *Macrosiphum gei* Koch; tarnished plant bug (Miridae), *Lygus pratensis* L., also by certain chewing insects, grasshoppers (Locustidae), *Melanoplus* spp.; flea beetles (Chrysomelidae), *Epitrix cucumeris* Harris and *Systena taeniata* (Say); leaf beetles (Chrysomelidae), *Disonycha triangularis* (Say), and Colorado potato-beetle larvae (Chrysomelidae) *Leptinotarsa decemlineata* Say.

Geographic distribution.—United States and Canada.

Genus 12. **Minuor** Zeller and Braun (1943)

Nanus Holmes p.p.

Viruses inducing general dwarfing or stunting of the plant as a whole or its parts; some species inducing intensification of green coloration of the foliage. Malformation and chlorosis absent or of little diagnostic value. Experimental transmission limited to tissue union; insect vectors not known. Type species: *Minuor ruborum.*

Minuor ruborum Zeller and Braun (1943)

Common name.—Raspberry decline-disease virus.

Host reactions.—In *Rubus idaeus* L. var. Cuthbert, when infection occurs late in the season, virus retards growth of new shoots and intensifies their reddish color the following spring. In the field the leaves on these canes show no symptoms until growth slows down in the autumn, when they roll downward and become fluted along the veins; leaves toward the cane tips show very slight chlorosis between the veins and a slight bronzing along the margins and crests between the veins; the cane internodes toward the tip are shortened. In greenhouse culture the downward rolling of the leaves is evident throughout the growing season. In the field, infected canes are small and weakened as evidenced by winter killing or failure of lateral buds; the feeder rootlets become reduced and the whole plant deteriorates progressively until death, which occurs at a maximum of about 3 years after infection. The berries are globose and the druplets separate readily, rendering the fruit worthless. Infection spreads from a diseased-plant center causing spotted areas that may be over 200 feet in diameter. Other varieties of *R. idaeus* and other species of *Rubus* have shown reactions resembling those induced by the decline-disease virus in the Cuthbert variety. All attempts to isolate and culture a parasite have failed.

Transmission.—By grafting; insect vectors not known.

Distribution.—Willamette Valley, Oreg.; possibly British Columbia.

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ZOOLOGY.—*Notes on a small collection of reptiles and amphibians from Tabasco, México.*[1] HOBART M. SMITH. (Communicated by HERBERT FRIEDMANN.)

Walter A. Weber, of the U. S. National Museum, naturalist to the Fifth National Geographic Society–Smithsonian Institution Expedition to southern México, under the leadership of Matthew W. Stirling, collected a small series of reptiles and amphibians near the base camp at La Venta, Tabasco. The material, now a part of the collections of the U. S. National Museum, was obtained in March and April, 1943. It was made available to me for study through the courtesy of Dr. Alexander Wetmore. It contains 12 specimens of nine species, five of which have not previously been recorded from the state of Tabasco, while one has not been collected for more than 50 years

[1] Received January 11, 1944.

and is among the great rarities of the Mexican herpetofauna.

La Venta is a heavily forested island about 4 miles across by 1½ miles wide located in the coastal swamps near the mouth of the Tonalá River, in the angle formed by the junction of that stream with the Río Blasillo. This point is about 15 miles inland to the southeast of the town of Tonalá on the Gulf coast.

Eleutherodactylus rhodopis (Cope)

A single specimen (U.S.N.M. 117556) was obtained on April 7. It is half grown and measures 25.3 mm from snout to vent. The markings and pattern of ridges are typical of the Atlantic coast specimens of the species.

This species has not previously been recorded from the state of Tabasco, although its existence there has been indicated by records from adjacent areas.

Agalychnis callidryas (Cope)

Two specimens (U.S.N.M. 117557–117558) were collected on March 24. They are immature, measuring 24 mm from snout to vent. The diagonal lateral cream lines are clearly evident in each. One is bright purple above, while the other has a strong gray suffusion nearly obliterating the purple color.

There are no records of this species in the literature for the state of Tabasco.

Anolis bourgaei Bocourt

A single specimen (U.S.N.M. 117348) is referred to this species, following the nomenclature proposed by Schmidt (Publ. Field Mus. Nat. Hist., Zool. Ser., 22: 491. 1941). It is a subadult male, with lateral light stripes.

The species has not previously been recorded from Tabasco.

Laemanctus deborrei Boulenger

One of the most valuable items secured is a specimen (U.S.N.M. 117349), collected on April 12, that proves to be the second known from México (the type is from "Tabasco") and perhaps the only one of the species in any American museum. It is a fine adult female carrying five eggs that average 26 by 15 mm in size. The snout-vent length is 120 mm, the tail 458 mm, the snout-occiput length (measured along the flat dorsal surface of the head) 41 mm.

The scales on the snout are not, or scarcely, larger than those in the occipital region; no prominently projecting scales on posterior edge of occiput; dorsal head scales strongly rugose, lateral head scales weakly rugose; about six canthals, the anterior in contact with first supralabial; one prenasal between first canthal and nasal; latter in contact with canthal series above and with supralabials (second and third) below; numerous loreal scales, a maximum of four in a vertical row from loreals to supralabials; five or six small suboculars, three or four in contact with supralabials; lores sloping *inward* slightly, as viewed from above; 11–12 supralabials; 11–11 infralabials; mental half as wide as rostral; gular scales weakly polycarinate, 21 in a row from mental to gular fold. Scales around middle of body 48; nape scales (sides and back) smooth; middorsal scales rather strongly keeled, especially just back of nape; paravertebral scales feebly polycarinate, becoming smooth in dorsolateral region; lateral scales feebly uni-, bi-, or tricarinate; belly scales rather strongly unicarinate. Dorsal scales on forelimb bi- or tricarinate, those on hindlimb (except foot) unicarinate; ventral limb scales unicarinate. Tail scales unicarinate, feebly above, strongly below. One of the most curious features in the scutellation of the species is the absence of keels on the subdigital lamellae—a character common to practically all iguanids. In their stead is a very curious, swollen, yellow or dark-brown knob in the middle of each lamella at its distal (free) edge. I know of no similar feature in other genera of iguanids, although it may occur in the related *Corythophanes*.

The coloration in life may well be much different from that seen in preserved specimens. Where the scales have been lost, the color is of various shades of purple; nine rather poorly defined, subrectangular, dark yellow spots about four scale rows wide form a vertebral series on the body, continuing dimly on the tail; the rest of the dorsal surfaces are of a dark wine color, the ventral surface a curious, striking, bright yellowish purple. The head is yellowish brown above and on the sides has scattered, purplish, greenish and yellowish

areas blending into one another. The posterior edges of the occipital shelf are black.

Ameiva undulata stuarti Smith

A single specimen (U.S.N.M. 117350) is apparently typical of this subspecies. The median gulars are in a single row, the largest larger than any mesoptychial or preanal; the preanals are in two rows; the femoral pores are 21–21, and the subdigital lamellae of the fourth toe are 30–32.

Apparently there is no previous record of the occurrence of this widely distributed species in Tabasco.

Ninia sebae sebae (Duméril and Bibron)

Three specimens (U.S.N.M. 117352–117354) were collected April 3 to 7. Respectively these have 138(♂), 133(♀), 134(♂) ventrals; 53, 44, 50 caudals; 6–6, 7–7, 7–7 infralabials; and 1–1, 2–2, 2–2 postoculars. The supralabials are 7–7 in all, temporals 1–2–3. The number of caudals in all three is less than is typical of *s. sebae*, with a total range of caudals from 51 to 71 in males and 40 to 60 in females; most males have over 54, most females over 45. In this character the specimens approach *s. morleyi*, in which the males usually have less than 54 (range 44 to 54), the females usually less than 45 (38 to 46). The three can not be referred to *s. morleyi*, however, for the known minimum ventral count for that race is 143 in females, 137 in males. It is not unreasonable to assume that the Tabasco specimens represent an intergrading population that still retains greater affinities to *s. sebae*.

Pliocercus elapoides elapoides Cope

A single specimen (U.S.N.M. 117351) of this subspecies, collected on April 17, is of considerable interest, since it represents an area from which the species is otherwise unknown. It is a female measuring 234 mm in total length, the tail 89 mm. The ventrals number 130, the caudals 97; supralabials 8–8; infralabials 9–9; preoculars and postoculars 2–2; temporals 1–1. The outer rings of each triad of black rings are much broader than the yellow rings; 12 primary black rings are on the body, 10 on the tail; and five of the anterior six black rings are incomplete ventrally.

The broad, secondary black rings, 9–9 infralabials, and 130 ventrals are characters that conclusively allocate this specimen with the typical race, although all other known specimens from Tabasco are clearly referable to *e. laticollaris*. The incomplete black rings, however, demonstrate an approach toward *e. laticollaris*. The Tabasco localities for the latter race (Macuspana, Teapa, Tenosique) are in the central and western part of the state and, moreover, are in or very near the foothills of the Atlantic escarpment. Intergradation between these two races is indicated for the area between La Venta, in extreme western Tabasco near the coast, and Teapa, located near the foothills of central southern Tabasco. Fairly typical *e. elapoides* may occur much farther eastward, however, near the coast.

As implied above, this specimen affords the first record of the occurrence of *e. elapoides* in Tabasco.

Coniophanes fissidens fissidens (Günther)

A male (U.S.N.M. 117555), collected on April 2, has 21–17 scale rows, 117 ventrals, incomplete tail, and 8–8 supralabials. The median border of the dorsolateral light stripes is indistinct in front of the anus, and the light stripes are visible on the neck. A dark spot near the end of each ventral is somewhat larger than other, scattered, black flecks. Though showing an approach toward *f. proterops*, especially in ventral markings, the specimen is clearly most like *f. fissidens*. It is noteworthy that La Venta specimens of this species show southern (eastern) affinities, while those of *Pliocercus* show northern (western) affinities.

Bothrops atrox (Linnaeus)

A single specimen (U.S.N.M. 117355) was collected on April 7. It is a half-grown female with 210 ventrals, 61 caudals, and 25–27–21 scale rows.

ZOOLOGY.—*Additional notes on Foraminifera in the collection of Ehrenberg.*[1]

J. A. CUSHMAN, Sharon, Mass.

In the summer of 1927 a visit was made to study the Foraminifera in the Ehrenberg collection in Berlin to determine if possible the characters and relationships of the numerous genera erected by Ehrenberg between 1838 and 1872. Notes on some of these have already been published in this JOURNAL 17: 487–491, 1927. As noted previously, there are many excellent original drawings that were never published which, with the specimens themselves, serve to give the characters needed to determine the systematic position of these genera. Notes are here given on a number of these genera and their probable relationships.

Asterodiscus Ehrenberg, 1838 (Abh. Akad. Wiss. Berlin, 1838: 130). The genoholotype is *A. forskâlii* Ehrenberg but is not figured. The type is from Santo Domingo and is the common species of that region. It should be placed as a synonym of *Planorbulina* d'Orbigny, 1826, and the species a synonym of *P. mediterranensis* d'Orbigny.

Omphalophacus Ehrenberg, 1838 (Abh. Akad. Wiss. Berlin, 1838: 132). The first species is *O. hemprichii* Ehrenberg (*l. c.*, p. 132). There are two lots of specimens in the Ehrenberg collection labeled "Tor" and "Erraia," respectively, but nothing more as to locality. They represent an unequally bilateral species of *Amphistegina*. The later species, *O.? tenellus* Ehrenberg (Mikrogeologie, 1854: pl. 32, pt. 2, fig. 34), was not found in the collection and is very difficult to determine from the figure. Its relationship was questioned by Ehrenberg himself. Therefore the genus *Omphalophacus* may be placed as a synonym of *Amphistegina* d'Orbigny, 1826.

Geoponus Ehrenberg, 1839 (Abh. Akad. Wiss. Berlin, 1839: 132). The genoholotype is *G. stella-borealis* Ehrenberg (*l. c.*, p. 132, pl. 1, figs. *a–g*). The type specimens are from living material from off Cuxhaven. In the Ehrenberg collection are excellent original figures in color showing pseudopodia. The large figures are in good detail with 8 to 10 retral processes to the chamber and 12 chambers to a coil. The retral processes are in pairs. This is definitely a synonym of *Elphidium* Montfort, 1808.

Entrochus Ehrenberg, 1841 (Abh. Akad. Wiss. Berlin, 1841: 408). The genoholotype is *E. septatus* Ehrenberg (*l. c.*, p. 426). The type specimen was examined. It is from Recent material off Veracruz and is evidently a small *Cassidulina* and should be placed as a synonym under that genus.

Megathyra Ehrenberg, 1841 (Abh. Akad. Wiss. Berlin, 1841: 409). Ehrenberg named two species, *M. dilatata* and *M. planularia*. The type specimens of these were examined. Both are from Recent material off Veracruz. The first species is very difficult to make out as to its full characters, but the second is very definite and indicates that the genus should be placed as a synonym of *Planularia* Defrance, 1824.

Porospira Ehrenberg, 1844 (Ber. preuss. Akad. Wiss. Berlin, 1844: 75). Two species were named by Ehrenberg in 1844, *P. princeps* and *P. comes*. Both are from Oran and were later figured (Mikrogeologie, 1854: pl. 21, figs. 92, 93). In the book of drawings in the Ehrenberg collection the second species was later labeled "*Rotalia* Reuss, 1861" after the genus. A study of the type specimens shows them to be somewhat trochoid and probably representing a single species. They should be placed as synonyms under *Anomalina* d'Orbigny, 1826.

Spirobotrys Ehrenberg, 1844 (Ber. preuss. Akad. Wiss. Berlin, 1844: 247). The genoholotype is *S. aegaea* Ehrenberg (*l.c.*, p. 248), from the Aegean Sea. The type is very evidently, as was later marked in ink on the original drawing, "*Planorbulina mediterranea*." There are two excellent unpublished figures in the Ehrenberg collection and the genus is definitely a synonym of *Planorbulina* d'Orbigny, 1826.

Rhynchospira Ehrenberg, 1845 (Ber. preuss. Akad. Wiss. Berlin, 1845: 358). The genoholotype is *R. indica* Ehrenberg (*l.c.*, p. 376). The locality given is "Pulo Pinang." The type specimen definitely shows that it is a synonym of *Globigerina* d'Orbigny, 1826.

Clidostomum Ehrenberg, 1845 (Ber. preuss. Akad. Wiss. Berlin, 1845: 358). The genoholo-

[1] Received February 5, 1944.

type is *C. polystigma* Ehrenberg (*l.c.*, p. 368). The type specimen was examined. It is from Loandra, South Africa. The internal siphon is well shown and the genus should be placed as a synonym of *Bolivina* d'Orbigny, 1839.

Grammobotrys Ehrenberg, 1845 (Ber. preuss. Akad. Wiss. Berlin, 1845: 368). The genoholotype is *G. africana* Ehrenberg from Loandra, South Africa. The types were examined and the genus should be placed as a synonym of *Virgulina* d'Orbigny, 1826.

Spiropleurites Ehrenberg, 1854 (Ber. preuss. Akad. Wiss. Berlin, 1854: 248). Of the two species named, only *S. nebulosus* Ehrenberg was figured (Mikrogeologie, 1854: pl. 35, pt. B, iv, fig. 7). The specimen from the Atlantic may possibly be a young form of *Globorotalia menardii* (d'Orbigny) although Sherborn's Index refers it to *"Pulvinulina repanda,"* which is an *Eponides*. Its position must therefore remain doubtful.

Pleurites Ehrenberg, 1854. There are several species figured under this genus in 1854, the first of which is *P. cretae* Ehrenberg (Mikrogeologie, 1854: pl. 27, fig. 32). It is from the Cretaceous of Meudon, near Paris. Ehrenberg had written later under the original figure *"Globigerina cretacea,"* but it is not this. A study of the type specimen shows it to have a smooth surface with the aperture and triserial arrangement of the chambers of *Bulimina*. It should therefore be placed as a synonym of *Bulimina* d'Orbigny, 1826.

Synspira Ehrenberg, 1854. The genoholotype, *S. triquetra* Ehrenberg, was figured (Mikrogeologie, 1854: pl. 29, fig. 47) from the Island of Moën. The single specimen at first appearance seems to be allied to *Nubecularia*, but it is apparently perforate and perhaps allied to *Spirillina*. From this single specimen the genus must remain doubtful.

Ceratospirulina Ehrenberg, 1858 (Monatsb. preuss. Akad. Wiss. Berlin, 1858: 11). The genoholotype is *C. sprattii* Ehrenberg (*l.c.*, p. 19). The type specimen is from 500 fathoms, in the Mediterranean between Malta and Crete. The species was originally called *mediterranea* in Ehrenberg's notes but later was crossed out and *sprattii* added above. On the original notes it was called *Ceratoloculina*. The later record as *Ceratospyris sprattii* (Abh. Akad. Wiss. Berlin, 1872 (1873): pl. 11, fig. 7) is the same. The early portion is definitely 5-chambered, and the generic names should be placed as synonyms of *Articulina* d'Orbigny, 1826.

Encorycium Ehrenberg, 1858 (Monatsb. preuss. Akad. Wiss. Berlin, 1858: 11, 19). The genoholotype is *E. nodosaria* Ehrenberg (*l.c.* p. 19) afterward figured by Ehrenberg (Abh. Akad. Wiss. Berlin, 1872 (1873): pl. 11, fig. 13). The specimen is well figured but evidently incomplete. Each chamber has a short internal neck, and the test as examined is clear, thin, and smooth. On the sheet of original drawings there are numerous notes later referring it to various genera, *Nodosaria*, *Frondicularia*, and *Glandulina*. From the evidence of the specimen it may questionably be referred to *Ellipsonodosaria* A. Silvestri, 1900, as a synonym.

Selenostomum Ehrenberg, 1858 (Monatsb. preuss. Akad. Wiss. Berlin, 1858: 12). Two species were named by Ehrenberg, *S. aegaeum* and *S. fimbriatum*. Both are Recent forms from the Aegean Sea. A study of the type specimens showed that the genus is a synonym of *Cassidulina* d'Orbigny, 1826.

Dexiopora Ehrenberg, 1858 (Monatsb. preuss. Akad. Wiss. Berlin, 1858: 309). The specimen figured as *D. triarchaea* Ehrenberg (*l.c.*, pp. 309, 337, pl. 1, fig. 10) is marked "untersilurischer Grünsand, Petersburg." Parker and Jones noted that it might be a *Globigerina*, but from an examination of the specimen it seems more like a concretionary form and so far as could be made out is without structure and the name should be allowed to lapse.

Spirocerium Ehrenberg, 1858 (Monatsb. preuss. Akad. Wiss. Berlin, 1858: 310). The genoholotype is *S. priscum* Ehrenberg (*l.c.*, pp. 310, 337, pl. 1, fig. 14). An examination of the type specimen shows it to be a globular mass of glauconite with no definite structure, and the name should be allowed to lapse.

Aspidodexia Ehrenberg, 1872 (Monatsb. preuss. Akad. Wiss. Berlin, 1872: 280). The genoholotype, *A. lineolata* Ehrenberg, was figured (Abh. Akad. Wiss. Berlin, 1872 (1873): pl. 3, fig. 4) from Recent Atlantic material. The original specimen was not found in the Ehrenberg collection, but the original figure was seen and the name had later been changed to *Aspidospira*. The latter is a synonym of *Anomalina* d'Orbigny, 1826. *Aspidodexia* is probably a synonym of *Globigerina* d'Orbigny, 1826.

MAMMALOGY.—*The type locality of* Tadarida mexicana *Saussure.*[1] SETH B. BENSON, Museum of Vertebrate Zoology, University of California. (Communicated by HERBERT FRIEDMANN.)

In checking a list of type localities of Mexican mammals I encountered an apparent error in designating the type locality of the Mexican free-tailed bat (*Tadarida mexicana*). Shamel (Proc. U. S. Nat. Mus. 78(art. 19): 5. 1931) gave the type locality as Ameca, Jalisco, Mexico, and stated: "The describer selects no specimen as type, but gives as the habitat the plateau of Mexico. Specimens are mentioned from Ameca, Jalisco, and from Cofre de Perote, Vera Cruz. In the United States National Museum collection are three specimens from San Pedro, Jalisco, which is in the immediate vicinity of Ameca, and 23 others from various places in Jalisco. I have therefore chosen Ameca, Jalisco, as the type locality. A specimen labeled, 'Mexico' (Saussure) and marked type of *Mollossus mexicanus* was examined in the Berlin Museum in 1904 by Mr. Miller who thinks it is probably a cotype."

This is not the first recorded designation of Ameca, Jalisco, as the type locality of this bat. The first known to me is by Miller (U. S. Nat. Mus. Bull. 79: 70. 1912), who gave no comment as to the reason. This ascription has been commonly followed in the literature. Also, there is an even earlier designation of the type locality. Elliot (Field Columbian Mus. Publ., zool. ser., 4: 629. 1904) gave the type locality as "Cofre de Perote, state of Vera Cruz, Mexico, 13,000 feet elevation," but gave no explanation.

Saussure's original description (Rev. et Mag. Zool., ser. 2, 12: 283–285. July, 1860) contains the following statement (p. 285) concerning distribution: "Habite le plateau du Mexique et les hautes montagnes. J'en ai tué un individu sur le Coffre de Perote, à 13,000 pieds d'altitude; d'autres individus ont été pris à Ameca, au pied du Popocatepetl, à un altitude de 8,500 pieds."

There is no mention of Jalisco in this statement, and the only way to infer that Ameca, Jalisco, is the locality intended is to assume that the phrases "au pied du Popocatepetl, à un altitude de 8,500 pieds" refer to a third locality. Actually, the punctuation indicates that only two localities are intended and that the phrases referred to merely describe the location of Ameca more exactly. Ameca really means Amecameca, a town situated on the western base of Popocatepetl at the approximate elevation given by Saussure. Perhaps an error in transcription is involved, easy to make with a word like Amecameca, or perhaps Saussure used the abbreviated form that is sometimes used by the present inhabitants of Amecameca and that appears on some maps. A further indication that Amecameca is the locality in question is furnished in Saussure's description of *Molossus aztecus* (*op. cit.*) where he gave its distribution (p. 286) as follows: "Habite le plateau du Mexique. Tué à Amecameca, au pied du Popocatepetl."

The localities recorded by Saussure are therefore Cofre de Perote, 13,000 feet, state of Veracruz, and Amecameca, 8,500 feet, state of Mexico. Because Saussure definitely stated that he collected a specimen on the Cofre de Perote himself, giving this locality first, and because Elliot first definitely fixed it as the type locality, Cofre de Perote, 13,000 feet, state of Veracruz, Mexico, should be considered the type locality of *Tadarida mexicana*. If it can be definitely established in the future that the specimen whose measurements are given by Saussure came from "Ameca," then Amecameca, state of Mexico, might be considered as the type locality, but there is no valid reason for ascribing the type locality to the state of Jalisco.

[1] Received January 31, 1944.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

1204TH MEETING

The 1204th meeting was held in the Cosmos Club Auditorium, Saturday, October 10, 1942, President BROMBACHER presiding.

The President announced that the Joseph Henry lecture could not be given, as the lecturer had received orders from the Navy Department calling him out of town. He acknowledged the Society's indebtedness to Mr. CHRISLER for volunteering to speak on very short notice.

Program: V. L. CHRISLER, National Bureau of Standards: *Field measurements of air-raid warning devices.*—Total war has created the necessity of warning the civilian population of impending air attacks. As acoustic signaling has proved to be an effective method of warning, the Office of Civilian Defense asked the National Bureau of Standards to make a study of various devices available for this purpose. Most of the measurements have been made in a large open space with the device mounted 20 feet above ground. Frequency analyses of the signals were made at a distance of 100 feet from each device and the intensity levels measured at distances of 100, 700, 1,400, and 2,800 feet. Varying atmospheric conditions, such as wind, temperature, and humidity, had considerable effect upon the attenuation of sound with distance; in fact, for the devices tested, the effect of atmospheric conditions is more important than the distribution of energy in the different frequency components. (*Author's abstract.*)

This illustrated paper was discussed by Messrs. W. G. BROMBACHER, A. G. MCNISH, W. J. HUMPHREYS, P. S. ROLLER, H. M. O'BRYAN, C. E. BENNETT, H. L. CURTIS, F. J. BATES, and P. A. SMITH.

1205TH MEETING

The 1205th meeting was held in the Cosmos Club Auditorium, Saturday, October 24, 1942, President BROMBACHER presiding.

Program: ALBERT MAY, Catholic University of America: *The latent image in the photographic plate.*—The present theories of the latent photographic image were discussed, including the work of Gurney and Mott and the attempts to explain the solarization region. This was followed by a description of original research.

Experiments in hypersensitization of X-ray emulsions with mercury vapor showed that no appreciable increase of speed of these emulsions was obtained for X-ray exposures, nor for films hypersensitized after exposure to visible light. The results were shown to be consistent with existing theories.

Blackening curves of exposures extended into the solarization region showed broader first maximum peaks for visible light than for X-ray exposures. Calculated curves based on a simple model give a satisfactory agreement with the X-ray curve, and an average of about 60 X-ray quanta is found necessary to produce solarization in a photographic grain. (*Author's abstract.*)

This paper was discussed by Messrs. W. J. HUMPHREYS, W. G. BROMBACHER, L. B. TUCKERMAN, and F. L. MOHLER.

1206TH MEETING

The 1206th meeting was held in the Cosmos Club Auditorium, Saturday, November 7, 1942, President BROMBACHER presiding.

Program: FREDERICK SEITZ, University of Pennsylvania: *The photoelasticity of crystals.*—Experimental investigations of the mechanism of plastic flow in crystals show that blocks of the material become displaced relative to one another along definite crystallographic planes. This mechanism is commonly known as *slip*. The linear dimensions of the blocks that play a role in the process of slip are of the order of 1 micron. Straightforward estimates of the shearing stresses that would be required to produce a slip in an ideal crystal lead to values of the order of magnitude of 10^{11} dynes per cm^2, whereas the values actually observed in well annealed single crystals of pure metals and salts are of the order of 10^7 dynes per cm^2. As a result of this fact it is necessary to assume that crystal imperfections play a very important role in determining the actual mechanism of flow. The present viewpoint of the nature of the lattice imperfections that have bearing on the problem was discussed. It was pointed out that a particular type of imperfection known as a *dislocation* would explain both the actual mechanism of slip and the observed values of the

shearing stress. There is evidence to show that a few dislocations are always present in well-annealed crystals; however, it is necessary to assume that many more are generated during plastic flow. The change in number of these alters the properties of the material in many respects. There is also evidence to show that fissures and cracks which play an important role in reducing the rupture strength of crystals aid in the generation of dislocations. (AUTHOR'S *abstract.*)

This paper was discussed by Messrs. W. G. BROMBACHER, L. B. TUCKERMAN, K. F. HERZFELD, A. BLAKE, and W. J. HUMPHREYS.

In an informal communication Mr. L. B. TUCKERMAN presented an illustration showing that it is not necessary for the derivative of a function to be zero at the maximum or minimum values. It was discussed by Messrs. A. BLAKE and W. J. HUMPHREYS.

1207TH MEETING

The 1207th meeting was a joint meeting with the Washington Academy of Sciences. It is reported in this JOURNAL 33: 32. 1943.

1208TH MEETING

The 1208th meeting was held in the Cosmos Club Auditorium, Saturday, November 21, 1942, President BROMBACHER presiding.

Program: D. R. INGLIS, Johns Hopkins University: *The moments of atomic nuclei.*—Like the earth, the atomic nucleus has in many cases an angular momentum and a magnetic moment. The electric quadrupole moment of several nuclei indicates an elongation of form somewhat analogous to the flattening of the earth. The magnetic moments are measured by means of the hyperfine structure of atomic spectra arising from different orientations of the nucleus in the magnetic field of the atomic electrons, and more accurately by inducing transitions of orientation at resonance of a radio frequency and a frequency of Larmor precession. The observed magnetic moments of odd proton nuclei with a given angular momentum tend to be divided into two groups as though to correspond to the two orientations of the odd proton spin relative to its orbital angular momentum. This must depend on a tendency of spin to pair off as far as possible. This and the distribution of quadrupole moments in the periodic table may in part be a consequence of a partial grouping of protons and neutrons into alpha particles in the nuclei. (*Author's abstract.*)

This paper was discussed by Messrs. W. G. BROMBACHER, P. A. SMITH, F. L. MOHLER, and F. C. BRICKWEDDE.

1209TH MEETING

The 1209th meeting was held in the Cosmos Club Auditorium, Saturday, December 5, 1942, President BROMBACHER presiding. The minutes of the 71st annual meeting were read and approved.

The Treasurer's report was read by the Treasurer, Mr. W. RAMBERG. The income from dues and investments during the past year was $1,215.16, and the expenditures were $1,014.55, leaving a surplus of $200.61. The average expenditure per member was $3.50. During the year the sum of $2,000 from the Trust account was invested in U. S. Saving Bonds.

The report of the Auditing Committee, A. BLAKE, R. P. TEELE, and E. H. VESTINE, was presented by the chairman, Mr. BLAKE. It was discussed by Messrs. W. J. HUMPHREYS and H. F. STIMSON. It was moved, seconded, and carried that the reports of the Auditing Committee and Treasurer be accepted as read.

The joint report of the Secretaries was presented by the Recording Secretary, Mr. F. L. MOHLER. There were 15 regular meetings during the year, with an average attendance of 55. At these meetings 16 papers were presented. The membership losses were 12, and there were 16 new members, giving 319 active members on December 1, 1942. There were 36 on the absent list. It was moved, seconded, and carried that the report be accepted as read.

The report of the Committee on Elections, F. WENNER, A. K. LUDY, and J. S. BURLEW, was presented by the Chairman, Mr. WENNER. He reported that those elected had received a majority of the votes with respect to the other candidates for the same office. It was discussed by Messrs. A. BLAKE and W. J. HUMPHREYS. It was moved, seconded, and carried that the report be accepted, and the President declared the following officers duly elected:

President: R. J. SEEGER
Vice Presidents: H. F. STIMSON, F. L. MOHLER
Recording Secretary: ARCHIE BLAKE
Treasurer: WALTER RAMBERG
Members-at-large of the General Committee: K. L. SHERMAN, W. A. WILDHACK.

The President opened the meeting for discussion of Society policies and recommendations to the General Committee. He remarked on the difficulty of securing papers and requested that members submit papers.

The Secretary read a rough draft of the minutes, and it was approved as read.

A paper on *Stellar explosions* was presented by Mr. GEORGE GAMOW, of George Washington University. It was discussed by Messrs. A. J. SHNEIDER, A. BLAKE, and W. A. WILDHACK.

The President requested Past Presidents BRICKWEDDE and MCCOMB to escort President SEEGER to the platform.

President SEEGER introduced the newly elected officers to the Society and thanked the retiring officers for their services.

1210TH MEETING

The 1210th meeting was held in the Cosmos Club Auditorium, Saturday, December 19, 1942, President SEEGER presiding.

The twelfth Joseph Henry lecture, *The scientific significance of ferromagnetism*, was delivered by Dr. FRANCIS BITTER. It was published in this JOURNAL **33**: 235–238. 1943.

1211TH MEETING

The 1211th meeting was held in the Cosmos Club Auditorium, Saturday, January 16, 1943, President SEEGER presiding.

The retiring President's address, *Altitude by measurement of air pressure*, was delivered by Dr. WILLIAM GEORGE BROMBACHER. (This paper will appear in this JOURNAL.)

The address was followed by some remarks concerning recent data on the same subject by Prof. PHILIP KISSAM, of Princeton University.

1212TH MEETING

The 1212th meeting was held in the Cosmos Club Auditorium, Saturday, January 30, 1943, President SEEGER presiding.

An invited paper, *Spectra of simple molecules*, was presented by Mr. G. H. DIEKE, of Johns Hopkins University. It was discussed by Messrs. F. G. BRICKWEDDE and A. BLAKE.

An informal communication on a graphical solution of certain problems in rate of work was made by Mr. W. EDWARDS DEMING. It was discussed by Mr. A. BLAKE.

The President announced the resignation of Mr. K. L. SHERMAN from the Committee on Communications and the appointment of Mr. A. G. MCNISH to fill the vacancy.

1213TH MEETING

The 1213th meeting was held in the Cosmos Club Auditorium, Saturday, February 13, 1943, President SEEGER presiding.

Program: ELIZABETH RONA, Trinity College: *Radioactivity of the ocean.*—It has been shown[1] that the ocean sediments, especially those lying below very deep water and far from the continent, have radium content 4 to 10 times greater than that of rocks, even of granite. In order to learn whether the origin of this high radium content can be explained by a chemical or biological precipitation from sea water, samples from different locations and different depths were investigated by H. Pettersson and the author,[2] and C. S. Piggott and Wm. D. Urry and the author.[3] In both sets of samples the amount of radium was found to be very low, in disagreement with the results found by former scientists, but in good agreement with R. D. Evans and collaborators.[4] The uranium content in the waters around the west coast of Sweden and in the northern Atlantic was found higher, as is necessary to uphold the equilibrium for radium found in the same samples, whereas in the sea bottom sediments the relation radium to uranium was just the opposite.

No possible explanation can be offered yet, until further investigations have been made. (*Author's abstract.*)

This paper was discussed by Mr. K. F. HERZFELD.

An informal communication on a queer but friendly function was presented by Mr. A. BLAKE. It was discussed by Messrs. A. G. MCNISH and L. B. TUCKERMAN.

1214TH MEETING

The 1214th meeting was held in the Cosmos Club Auditorium, Saturday, February 27, 1943, President SEEGER presiding.

Program: Dr. RICHARD C. TOLMAN, National Defense Research Committee: *Physical science and philosophy.*—This paper presented certain philosophical reflections as to the nature of

[1] PIGGOT, C. S., and URRY, WM. D. Amer. Journ. Sci. **239**: 91. 1941.
[2] Göteborg's Kungl. Vet. Vitt.-Samhallas **6**(12). 1939.
[3] Not yet published.
[4] Amer. Journ. Sci. **36**: 241. 1938.

science, with illustrations drawn particularly from physics. The relative scopes of science and philosophy were first defined. In accordance with the limited scope of science, it was pointed out that the methods and results of science may all be characterized as objective and abstract. The objective and abstract characters of science were then discussed.

The test of objectivity was taken as that of common agreement and acceptance. Difficulties in applying this test were mentioned and two factors that help to control these difficulties were noted. Justification was presented for the circumstance that philosophy must make use of methods and results that are not objective. It was emphasized that the limitation of science to methods and results that are objective does not limit the fields of human interest to which scientific studies may be profitably applied.

The abstract character of science was taken, in the first place, as arising from the necessity of abstracting out that which is objective from the general consideration that men give to their experience. This led to a discussion of the relation between the subjective origins and objective outcome of scientific work.

The abstract character of science was taken, in the second place, as arising from the circumstance that each particular science abstracts a particular kind of phenomena for consideration. This led to a discussion of the Comte principle for the organization of the sciences into a hierarchy in accordance with the different levels of abstraction which they employ. With the help of this principle, the relations between different sciences were discussed. This discussion was illustrated by the relations of physics and chemistry—statistical mechanics and thermodynamics—kinematics, dynamics, and electrodynamics—physics and biology—and physics and psychology. The view was expressed that phenomena at one level of abstraction can not be completely treated at a deeper level of abstraction. (*Author's abstract.*)

This paper was discussed by Messrs. T. DANTZIG, P. S. ROLLER, A. G. MCNISH, H. E. MCCOMB, W. P. WHITE, H. C. DICKINSON, K. F. HERZFELD, and R. J. SEEGER.

1215TH MEETING

The 1215th meeting was held in the Cosmos Club Auditorium, Saturday, March 13, 1943, President SEEGER presiding.

Program: FREDERICK D. ROSSINI, National Bureau of Standards: *Modern thermochemistry.*—There was described the work of the National Bureau of Standards in thermochemistry, including a description of the method and apparatus, presentation of some of the experimental results, and application of the data in calculating chemical equilibria among hydrocarbons. The following topics were covered: The substitution method for comparing electrical energy with chemical energy, apparatus for reactions in a flame at constant pressure, apparatus for reactions in a bomb at constant volume, determination of the purity and amount of reaction, heats of formation and of isomerization of the paraffin and olefin hydrocarbons, and free energies of formation and equilibria of isomerization of the paraffin hydrocarbons. Some practical applications were briefly mentioned. (*Author's abstract.*)

This paper was discussed by Mressrs. H. L. CURTIS, L. B. TUCKERMAN, A. BLAKE, H. C. DICKINSON, and W. J. HUMPHREYS.

L. B. TUCKERMAN, National Bureau of Standards: *Early use of meteoric iron in weapons* (informal communication).—A paper in Poggendorff Annalen **26**: 350–352, 1832, *Account of an aerolith which fell some time ago in the Orient*, reported by the Chief Librarian of the Leipzig Royal Library, Prof. Dr. WILKEN was cited.

The Persian manuscript from which the following accounts are taken is to be found in the Leipzig Royal Library (Ms. Orient in 8vo No. 97). It was written in the sixth year of the reign of the Indian Padischah Mohammedschah (1723 A.D.). It has no title but contains the history of the Indian kings up to the time of the Padischah Mohammed Ewrengzeb, that is, up to the beginning of the eighteenth century.

It is preceded by an introduction in the manner of an encyclopedia in which many facts of physics, in particular meteorological appearances such as hail, rain, and snow, are discussed. In the discussion of storms the following accounts are given:

"It was reported by the Sheik Erreis, that a piece of iron weighing 150 men[5] fell one day in the neighborhood of Dschordschan, and the inhabitants of the region heard a remarkable

[5] The weight of the men is very differently reported, so much so that the values range between 40 pounds and 2 pounds.

noise. The parts of the piece of iron were arranged in the manner of grains of millet.[6] The piece of iron was brought to the Mayor of Georgia, whereupon the Sultan Mohammed of Gasnevide (reigned from 999 to 1030 A.D.) requested a part of it, which was brought to him. The Sultan commanded that a sword should be made of it, which however was not found possible."

"It is reported that in the sixteenth year of the reign of Padischah Dschehangir (1621 A.D.) a very loud noise from the East was heard one morning in the neighborhood of Dschalinder (a northern district of India) and at the same time a bright light like lightning was seen to fall down and vanish. Mohammed Said, the Mayor of this region, ordered that the place where it fell should be dug up. A piece of hot iron was found, which was brought under seal to the court and the Padischah Dschehangir ordered Master Smith David to make him a sword and dagger from it. The smith, however, stated that this iron would not hold together under the hammer, but could only be forged if it was mixed with another iron. Accordingly, such a mixture was made. Three parts of the lightning iron and one part of another iron were mixed together. From the mixture two swords, a dagger, and a knife were made, which, in cutting and wounding, were equal to the finest swords. Their design was excellent, although they bore no resemblance to the design of our swords." (*Author's abstract.*)

1216TH MEETING

The 1216th meeting was held in the Cosmos Club Auditorium, Saturday, March 27, 1943, Vice-President STIMSON presiding.

Program: PAUL R. HEYL, National Bureau of Standards (retired): *The genealogical tree of modern science.*—Published in this JOURNAL 33: 327–334. 1943.

[6] I am not sure whether the word "gawirs" appearing in the Persian text is rightly translated by millet. The Sultan Von Aude in his book on the "Seven Seas" makes the following statement concerning this word (which was lacking in previous Persian dictionaries): "*Gawirs* is used to mean *millet*, but according to others it means *grain*, God knows." In the latest edition of Richardson's Persian dictionary the word is explained as meaning a kind of vetch. In any case the comparison with "gawirs" appears to be used to represent the kernellike appearance of the meteor stone.

This paper was discussed by Messrs. SHNEIDER, F. L. MOHLER, A. G. MCNISH, and KNAPP.

An informal communication on the invention of the magnetic compass in Europe was made by Mr. P. R. HEYL.

1217TH MEETING

The 1217th meeting was held in the Cosmos Club Auditorium, Saturday, April 10, 1943, President Seeger presiding.

Program: Rev. PAUL A. MCNALLY, S.J., Georgetown University: *The universe in which we dwell.*—The purpose of this lecture was to give a popular survey of the growth of man's knowledge in the field of astronomy, using as a unifying element the notion of distance.

Starting with a universe—Egocentric, since man was concerned, then, for the most part with himself and his immediate surroundings—whose limits were, probably, thought to be only a few hundreds of miles distant, the steps of man's progress in this field of knowledge may well be described under the captions or epochs —Geocentric, Heliocentric, Astracentric, Nebulacentric. During these epochs the size of the known universe grew—from the time when the boundaries of the universe were thought to be only a few thousands of miles away, until the present, when we know that the most distant objects in the skies—so far revealed by our largest telescopes—are hundreds of millions of light years distant.

Since the present year marks the four-hundredth anniversary of the death of Copernicus, special emphasis was given to the size and shape of the known universe of 1543 and the consequent revolution of thought occasioned by the introduction of the heliocentric theory.

A summary of the most recent scientific speculations on the nature of the "red shift" found in the spectra of the most distant objects in the sky was introduced to bring out the element of uncertainty in our present knowledge of the size of the known universe. (*Author's abstract.*)

This paper was discussed by Messrs. A. BLAKE, K. F. HERZFELD, A. G. MCNISH, and C. L. GARNER.

1218TH MEETING

The 1218th meeting was held in the Cosmos Club Auditorium, Saturday, April 24, 1943, President SEEGER presiding.

Program: G. RUPERT GAUSE, War Department: *Statistical control of quality in manufacturing and inspection.*—Variations in the quality of any material produced by mass production processes are of two types: natural variations inherent in the production process itself, and extraneous variations not inherent in the process itself, but for which assignable causes exist. Statistical quality control distinguishes between these two types of variations, and indicates when and where extraneous variations occur so that their cause can be eliminated. The control chart is a device for making this distinction in a routine fashion. It is a graphic record of inspection results, with limit lines to indicate when corrective action should be taken on the production process.

Consumer acceptance inspections exert a strong influence on the quality level which a manufacturer maintains, and they must be sound if proper levels are to be enforced. Since no one sampling procedure will accept every lot of satisfactory quality and reject every lot of unsatisfactory quality, inspection results obtained on successive lots must be summarized to obtain a precise measure of overall quality. If this quality is unsatisfactory, very strict acceptance procedures must be used; if consistently satisfactory, the amount of inspection can be reduced and major attention focused on unsatisfactory sources. (*Author's abstract.*)

This paper was discussed by Messrs. TUTTLE, M. GOLDBERG, F. B. SILSBEE, BELLISON, PAUL NORTON, CARLTON, T. C. LYONS, and HORACE NORTON.

1219TH MEETING

The 1219th meeting was held in the Cosmos Club Auditorium, Saturday, May 8, 1943, President SEEGER presiding.

Program: RICHARD COURANT, New York University: *Stability and instability as demonstrated by soap films.*—Mathematical and physical methods often supplement each other in a manner whereby each throws light on the other's problems. This fact is well illustrated in the problem of Plateau, the problem of passing a surface of minimal area through a given closed space curve.

Interesting results on this problem, derived at length by the methods of the calculus of variations, may be illustrated by means of soap films made by dipping wires in the prescribed forms into a solution of soap and glycerine. The soap film assumes the shape of minimal potential energy, which is the same as the shape of minimal area, and accordingly solves the problem of Plateau.

The wires may be distorted or otherwise moved in such a way as to cause the soap film to pass from a configuration which is stable for one shape of wire to a topologically different configuration stable for another shape. (*Secretary's abstract.*)

This paper was discussed by Mr. A. G. MCNISH.

The meeting was adjourned early (9:35 P.M.) for the social hour to enable the members to experiment with the soap solution and wire apparatus, which the speaker had brought to demonstrate the manner in which soap films solve the problem of Plateau.

1220TH MEETING

The 1220th meeting was held in the Cosmos Club Auditorium, Saturday, May 22, 1943, President SEEGER presiding.

Program: J. J. HOPFIELD, National Bureau of Standards: *The Raman effect in chemical compounds.*—If a molecule has a permanent dipole moment, it will absorb infrared light, and the frequencies of vibration of the molecule are the frequencies of the absorbed light.

Raman spectra, on the other hand, are observed in the light scattered by molecules. This process of scattering is very inefficient so that weak lines are generally obtained. In this process of scattering the electric vector of the incident light *induces* a dipole moment in the molecule, and the *frequency differences* between the incident light and the Raman scattered light are the frequencies characteristic of the molecule. A strong spectrum of a few lines (Hg) and a fast spectrograph are necessary for easily observing these Raman spectra.

Since Raman spectra are characteristic of the observed molecules, their ions, or valence groups, one can use them as tools for identifying compounds, for quantitative analysis, for detecting the presence of various types of ions, for identifying various types of bonds or link-

ages, for the isotope effect, and in connection with the theory of molecular structure.

A unique use of Raman spectra is in the study of materials in aqueous solution in a low frequency range corresponding to one in the infrared in which water is too opaque for use. (*Author's abstract.*)

This paper was discussed by Messrs F. G. BRICKWEDDE, F. L. MOHLER, A. BLAKE, and MANOV.

Mr. L. B. TUCKERMAN presented three informal communications, on Dr. Raman, on dishonesty in advertising, and on Professor Persy's formula.

ARCHIE BLAKE, *Recording Secretary.*

Obituaries

NATHAN SANFORD OSBORNE, principal physicist at the National Bureau of Standards, died at his home in Washington, D. C., on September 18, 1943, after a long illness. Born at Southampton, N. Y., on February 10, 1875, he attended the public schools in Southampton and the Michigan College of Mines, where he received the degree of mining engineer and membership in Tau Beta Pi in 1899. The next few years were spent partly in the practice of mining engineering and partly as instructor in mathematics and physics at the Michigan College of Mines. His real bent, however, was for precise physical measurements, and his opportunity came when he joined the staff of the National Bureau of Standards in 1903. He served, until his death, as a member of the staff of the Bureau for a total of 38 years, continuously except for a period from 1910 to 1912, during which he was an instructor at the Michigan College of Mines.

He was married in 1910 to Lura M. Krebs, and is survived by her, by a daughter, Mrs. Douglas Robertson, and a son, Robert.

His first major scientific investigation was of the density and thermal expansion of ethyl alcohol and its mixtures with water. The tables based on the data obtained are still the standard of the United States Treasury and other departments of the Federal Government and are widely used in industry.

He returned to the Bureau in 1912 to participate in and later to take the leading part in the determination of the physical constants of interest to the refrigerating industry. After a series of determinations of the specific heat and heat of fusion of ice, the work on properties of ammonia was begun. This investigation covered the entire range of temperature and pressure likely to be useful in refrigeration and included determination of the properties of saturated liquid and saturated and superheated vapor. The work was extensive enough to provide a basis for complete tables of the thermodynamic properties of ammonia, published in 1923. These tables were accepted both here and abroad as authoritative and are still considered so by the engineering profession.

The work on ammonia served as a model for later investigations, and its completion doubtless was influential in leading the steam power industries to initiate a similar program on the properties of water and steam. The ammonia program had, however, consisted of a series of separate investigations which were brought together and correlated after completion. Osborne was not satisfied with this rather unsystematic procedure, and before beginning the researches on water and steam he worked out a much more systematic method of dealing with the problem, published under the title *Calorimetry of a fluid.* In this paper he outlined and described a procedure for determining the principal thermodynamic properties of a liquid and its vapor, using a suitably designed calorimeter for a series of correlated measurements. This method was the basis for the later work on properties of steam. He also planned an extension of the method to include some of the properties of the superheated vapor, but this part of the method has not yet been used.

Although educated as an engineer, Dr. Osborne attained eminence in the engineering world, not through the practice of his profession but by contributing for its use some of the fundamental physical data which are the foundation of engineering. His work has received wide recognition, as in the International Steam Tables, a large part of which is based on his work. He was a delegate to the three International Conferences on the Properties of Steam, held in England, Germany, and the United States in 1929, 1930, and 1934, respectively, and contributed much to their success. He was hon-

ored with the degree of doctor of science by Stevens Institute of Technology and the degree of doctor of engineering by the Michigan College of Mines. He was a member of the Philosophical Society of Washington and of the Washington Academy of Sciences.

It is fortunate that Dr. Osborne's work was done at a time when the equipment for measurements of temperature and pressure, and other factors required, had been perfected to such an extent that in combination with his own developments in calorimetry the accuracy attainable and actually attained was ample for engineering purposes, and adequate for present-day scientific requirements. It seems possible that the results of his work will be considered as definitive, and there is at present no prospect that the work will need to be repeated for many years to come.

In the design and construction of the apparatus required for his work, Dr. Osborne was reluctant to follow conventional practice until he had convinced himself that it was better than any new and original methods that he could devise. He became a skilled instrument maker and himself constructed some of the more delicate and difficult parts of his apparatus and produced some examples that could bear comparison with the product of the most skilled mechanics. He was always ready to give the benefit of his ideas and experience to anyone who asked for it, and in this way he made many valuable contributions to the work of others.

E. F. MUELLER.

EDWARD BENNETT MATHEWS, emeritus professor of mineralogy and petrography at Johns Hopkins University, died on February 4, 1944.

Dr. Mathews was born in Portland, Maine, on August 16, 1869. He received the bachelor's degree at Colby College in 1891 and was awarded the honorary doctor of science degree in 1928 as one of its most distinguished alumni. He received his training in mineralogy and petrography at Johns Hopkins University under Dr. George Huntington Williams. He was awarded the degree of doctor of philosophy in 1894 and was then appointed instructor in mineralogy and petrography upon the untimely death of his eminent teacher. From 1891 to 1894 he was a field assistant on the United States Geological Survey. In 1904 Dr. Mathews was promoted to the professorship in mineralogy and petrography and in 1917, upon the death of William Bullock Clark, succeeded him as chairman of the Department of Geology, which position he held until his retirement from active university duties at the age of 70 in 1939.

Soon after the Maryland Geological Survey was established in 1896, Dr. Mathews became assistant state geologist and in 1917 succeeded William Bullock Clark as state geologist, a position he held until compelled to retire on account of ill health in 1943. He was an important contributor to most of the volumes published by that Survey from his *Bibliography and cartography of Maryland* in volume 1, published in 1897, to the *Gazetteer of Maryland*, published as volume 14 in 1941. His contributions covered such fields as the petrography and structure of the piedmont, the building and ornamental stones, the limestones, the coals, the clays, the surface and ground waters, the mineral industries, and the physical features. Interest in history, bibliography, and cartography is reflected in such works as the *Bibliography and cartography of Maryland*, the *Catalog of published bibliographies in geology*, *The counties of Maryland and their origin*, *Maps and map makers of Maryland*, the report on the *Resurvey of the Mason and Dixon Line*, the report on the *Location of the boundary line along the Potomac River between Maryland and Virginia*. It was these same interests that impelled him throughout the years of his teaching to accumulate analyses of igneous rocks from all over the world, which culminated in the last years of his career as a Geological Society of America project under which he completed a search of geologic literature to assemble all extant igneous-rock analyses and arrange them geographically by latitude and longitude.

Dr. Mathews also served his adopted State in many other capacities, the range of which likewise testifies to the diversity of his knowledge and interests. He was director of the Maryland Weather Service from 1917 to 1933, executive officer of the State Board of Forestry from 1917 to 1925, member of the Maryland Development Commission, and member of the Water Resources Commission from its establishment in 1933 until it was merged in 1941 with the Maryland Geological Survey into the

Department of Geology, Mines, and Water Resources of which he became director.

Outside of Maryland, he served as chairman of the Division of Geology and Geography of the National Research Council from 1922 to 1925, as chairman of the Advisory Council of the United States Board of Surveys and Maps, as vice president and treasurer of the Sixteenth International Geological Congress, and as treasurer, member of the finance committee, and councillor of the Geological Society of America from 1917 until his death.

The diversity of his interests made him a great traveler and student of the classical geologic areas of Europe and other parts of the world, experiences that greatly enriched his knowledge of geologic history, places, and persons. This store of knowledge and experience he was ever ready to share with friends, colleagues, and students, who found him an unending and never-failing source of information.

The impelling motives that led Dr. Mathews into this wide range of activities were an innate intellectual curiosity and an unselfish desire to be of service and usefulness to others, and never an urge to display unusual wisdom or to bring himself into the limelight. He adroitly avoided public and formal exhibition of the versatility and range of his knowledge and experience but was always ready and willing to share them unobtrusively and informally in friendly conversation.

JOSEPH T. SINGEWALD, JR.

EDWARD OSCAR ULRICH, geologist and paleontologist, died on February 22, 1944, at the age of 87. He was born in Cincinnati, Ohio, on February 1, 1857, of parents who had come to the United States from Alsace in 1840. His father had been a soldier in the French Army, serving at one time as the commandant of a fortress in Algeria. His early education was received in the public schools of Cincinnati and of Covington, Ky. He later attended German Wallace and Baldwin Colleges, at Berea, Ohio, receiving the A.M. degree in 1886 and the Ph.D. degree in 1892. In deference to his father's wishes, he attended Pulte and Ohio Medical Colleges from 1876 to 1878, but did not complete the work for a medical degree.

Dr. Ulrich's early career was rather varied. He worked at his father's trade of carpenter and as a rodman for the waterworks department of Cincinnati, receiving his first impetus toward geology in connection with excavations for a city reservoir. In 1877 he became curator for the Cincinnati Society of Natural History. From 1880 to 1883 he was superintendent of the Little Caribou Silver Mines in Boulder County, Colo. For some years he worked intermittently as draughtsman, lithographer, and carpenter to provide a livelihood while he carried out his paleontologic investigations. From 1885 to 1889 and from 1891 to 1897 he was paleontologist for the Geological Surveys of Illinois, Minnesota, and Ohio; in 1890 and 1891 he was assistant geologist for the Kentucky Geological Survey. He joined the U. S. Geological Survey in 1897, remaining with it until his retirement in 1932. In 1914 he became an Associate of the U. S. National Museum and continued to hold that place until his death. He had been a member of the Washington Academy of Sciences since 1903.

Dr. Ulrich was an original fellow of the Geological Society of America, and had served as president of the Paleontological Society and the Geological Society of Washington. He was a member of the National Academy of Sciences and a corresponding member of the Geological Society of London and the Geological Society of Stockholm. He received in 1930 the Mary Clark Thompson medal of the National Academy and in 1932 the Penrose medal of the Geological Society of America.

He pioneered in many paleontologic fields. He was one of the first students of the stony Bryozoa, and his work there is fundamental. He was one of the earlier students of the conodonts, and his work on Paleozoic ostracods led to a classification that has been widely adopted. He participated in the preparation of numerous areal and stratigraphic reports and at times took a hand in purely economic papers, such as those dealing with copper deposits in Missouri and lead, zinc, and fluorspar deposits in Kentucky. He proposed radical changes in parts of the generally accepted stratigraphic classification, particularly in a major work entitled *Revision of the Paleozoic systems.*

Dr. Ulrich married Albertine Zuest in Cincinnati in 1886 and in 1933 in London Lydia Sennhauser, who survives him. There were no children.

JOHN B. REESIDE, JR.